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USSR Report

MATERIALS SCIENCE AND METALLURGY

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USSR REPORT

MATERIALS SCIENCE AND METALLURGY

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UDC: 620.178.3;639.219.2

DEVELOPMENT OF SURFACE CRACKS IN AMg6 ALLOY UNDER LOW-CYCLE LOADING
CONDITIONS

Kiev PROBLEMY PROCHNOSTI in Russian No 7, Jul 84
(manuscript received 19 Jan 84) pp 23-32

STRIZHALO, V. A., KRASOVSKIY, A. Ya., KALLINSKIY, A. L. and KPAMARENKO, I. V.,
Institute of Strength Problems, Ukrainian Academy of Sciences, Kiev

[Abstract] Results are presented from a study of the process of development of fatigue cracks during low-cycle loading of sheet rolled AMg6 alloy 10 mm thick. The studies were performed on flat specimens made of rolled sheet goods without surface treatment, with surface cracks. The experimental methods were developed considering the basic principles of low cycle fatigue testing. Studies began with static tensile testing. Studies of the fracture surface revealed that fracture under static conditions occurred by a micro-mechanism of birth, development and merging of microscopic pores. A macro-plastic zone was seen throughout the entire range of loads and crack lengths studied. Fracture in all cases occurred after a surface crack reached the opposite side of the specimen and became a penetrating aperture. The growth rate of the penetrating aperture is an order of magnitude higher than the growth rate of surface cracks for the same load. Good agreement of the macroscopic crack development rate determined by the method of labels and the microscopic rate determined by the spacing of fatigue furrows was achieved at crack growth rates of 10^{-6} to 10^{-5} meters per cycle. Metal anisotropy was found to influence formation of fracture surface microrelief. Figures 13; references 18: 9 Russian, 9 Western.
[146-6508]

K_{I*} -n DIAGRAM OF CYCLICAL CRACK RESISTANCE OF ALUMINUM ALLOYS

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 4, Jul-Aug 84
(manuscript received 7 Sep 83) pp 148-153

IVANOVA, V. S. and KUNAVIN, S. A., Moscow

[Abstract] The K_{I*} -n diagram is presented for aluminum-based alloys, relating n to the threshold values of K_{I*} corresponding to the boundaries of self-similar crack growth. Macro- and microfractographic methods of fracture analysis were used to determine the threshold values of K_{I*} . The values of K_{I*} corresponding to agreement between macroscopic crack growth rate and microscopic rate, calculated from the ferrostep, were also determined. The parameter n represents the sensitivity of the material to cracks and K_{I*} represents the boundary of self-similar crack growth. Equations are derived for calculation of the boundaries of similar crack growth on the basis of parameter n when the maximum and minimum elastic-plastic constriction are realized. The data obtained show that stage II of fatigue crack growth corresponds to the characteristic signs of self-similarity. Figures 5; references 14: 8 Russian, 6 Western.
[145-6508]

UDC: 669.71'793'74

NATURE OF PHYSICAL-CHEMICAL INTERACTION IN ALUMINUM-RICH PORTION OF Al-Sc-Mn SYSTEM

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 4, Jul-Aug 84
(manuscript received 1 Dec 82) pp 221-224

DRITS, M. Ye., TORPOVA, L. S. and GUSHCHINA, F. L., Moscow

[Abstract] Studies of the Al-Sc-Mn system were performed in the area of alloys containing up to 3% Sc and 3% Mn. Polythermal and isothermal cross sections were constructed using the method of differential thermal analysis, investigation of the microstructure of cast, deformed and annealed alloys, x-ray phase analysis and scanning electron microscopy. It was established that nonvariant eutectic transformation occurs at $649 \pm 2^\circ\text{C}$ in this area. Two binary compounds are in equilibrium with the aluminum solid solution: Al_3Sc and Al_6Mn . Scandium significantly decreases the solubility of manganese in aluminum. Figures 3; references 4: all Russian.
[145-6508]

INFLUENCE OF EXCESS PHASES ON FRACTURE TOUGHNESS OF CAST ALUMINUM-MAGNESIUM-ZINC ALLOY

Ordzhonikidze IZVESTIYA VYSSHIKH UCHENBYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 3, May-Jun 84 (manuscript received 13 Jun 83) pp 78-83

BELOV, N. A., YEVSEYEV, Yu. V. and ZOLOTOREVSKIY, V. S., Moscow Institute of Steels and Alloys, Department of Metallography of Nonferrous Metals

[Abstract] A study is made of the influence of excess phases of crystallization origin on the fracture toughness of Al+7% Mg+3% Zn with the addition of iron, silicon, and copper, as well as the influence of the addition of such transition metals as manganese, titanium, chromium and zirconium. Specimens for the study were prepared in an electric resistance furnace in a graphite-chamotte crucible. After refining with hexachloroethane they were poured at 710-720°C into a steel mold with inner cavity 20 x 200 x 800 mm allowing a cooling rate of about 200 K/min. The 2-kg ingots produced were hardened (430°C, 10 hours, quenching in water) then 13 x 26 x 120 mm specimens were cut for fracture toughness of alloys containing 0.1% Ti, 0.1% Zr, 0.2-0.8% Mn and 0.3% Cr were studied. The phases Mg₂Sr and Ti(Al, Mg, Zn, Cu) were found to decrease fracture toughness more strongly than did FeAl₃. Small quantities of the transition metals could increase fracture toughness, while the formation of excess phases of crystallization origin and large secondary inclusions was accompanied by a decrease in fracture toughness. Figures 4; references 10: 9 Russian, 1 Western. [143-6508]

STUDY OF SUPERPLASTIC ALLOYS BASED ON Al-Zn-Ca

Ordzhonikidze IZVESTIYA VYSSHIKH UCHENBYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 3, May-Jun 84 (manuscript received 12 Jan 83) pp 70-74

PORTNOY, V. K. and IL'YENKO, V. M., Moscow Institute of Steels and Alloys, Department of Metallography of Nonferrous, Rare and Radioactive Metals

[Abstract] The task of this work was to study and optimize conditions of production and superplastic deformation of sheets of alloys in the system Al-Zn-Ca and to determine the possibility of hardening alloys by additional alloying. Ingots of Al-5% Zn-5% Ca (ATSK) 150 x 200 x 30 mm were produced and three cooling rates used to determine the influence of cooling rate of superplasticity. It was found that the casting properties of ATSK with composition on the double eutectic line are favorable for the production of good quality ingots under various casting conditions. Workability was insufficient to produce rolled products without cracks below 500°C, so

further studies were performed on sheets hot rolled at 500 and 580°C. Structural studies showed that in the superplastic state, ATSK alloy has a fine grain structure consisting of an aluminum solid solution (α -phase) and complex intermetallide, probably CaZnAl_3 . The influence of the addition of magnesium and copper on strength of the alloy at 20°C was studied. Copper was found to be less effective than magnesium at hardening. Superplasticity appeared at 400-600°C, and the optimal rolling temperature was 550°C, optimal superplastic deformation rate 10^{-2} s^{-1} . Increasing crystallization rate during casting helps to increase relative elongation in superplastic deformation of sheet products. Up to 2% magnesium improved strength without reducing workability. Figures 5; references 6: 3 Russian, 3 Western.

[143-6508]

CHEMISTRY INSTITUTE'S ADVANCES IN MAKING EXTRA-PURE ALUMINUM

Moscow TRUD 30 Oct 84 p 3

KHAMIDOV, R.

[Abstract] The article reports on advances in obtaining extra-pure aluminum at the laboratory of metallurgy of pure metals of the Tadzhik Academy of Sciences' Institute of Chemistry. The head of the laboratory is Doctor of Technical Sciences, Prof. Anvar Vakhobov. It is claimed that the laboratory's researchers have developed a process for obtaining aluminum in which the content of impurities does not exceed one ten-thousandth of one percent. The process is said to rely on conventional equipment and technological procedures which were perfected long ago. Therefore it is thought that a real possibility exists for making it an industrial process in a relatively short period of time. According to Vakhobov, the laboratory's experimentation with the process and its product also has included applications, and in addition to machine building and electronics, applications are seen in cryogenic and solar-energy technology. It is said that extra-pure aluminum is one of the metals that can hold up in cryogenic conditions, becoming a 'hyperconductor,' and that in solar-energy systems it is more effective and economical than alloys currently used. It is also claimed that aluminum that is 99.99999 percent pure has been obtained in a vacuum-heating unit in the laboratory.

FTD/SNAP
CSO: 1842/014

UDC: 669-158:539.213

FORMATION OF AMORPHOUS METAL STRIP DURING HARDENING OF A MELT

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 4, Jul-Aug 84
(manuscript received 4 Jan 83) pp 82-85

BORISOV, V. T. and SREBRYANSKIY, G. A., Moscow

[Abstract] A theoretical analysis is presented of the hydrodynamic and thermal processes occurring upon formation of a strip from a jet of melt. An equation is derived which defines the dynamics of formation of the liquid layer in which the melt flowing from the nozzle is in contact with the surface of a rotating cylinder. The process consists of two stages: capture of a thin melt layer and dynamic extension of the layer to the point of final solidification as an amorphous strip. The theoretical analysis of the spinning process allows quantitative estimation of factors defining the thickness of the strip and its cooling rate. Figures 2; references 6: all Western.
[145-6508]

UDC: 612.039;536.46

INFLUENCE OF INITIAL STATE OF COBALT-BASED AMORPHIZED ALLOY BOMBARDED WITH α -PARTICLES ON STRUCTURE OF GAS LIBERATION SPECTRA UPON LINEAR HEATING

Moscow POVERKHNOST' in Russian No 7, Jul 84 (manuscript received 6 Dec 82; final form received 24 Feb 83) pp 125-128

ZALUZHNYI, A. G., STOROZHUK, O. M., CHEREDNICHENKO-ALCHEVSKIY, M. V., CHUYEV, V. I. and RYAZANOV, A. I.

[Abstract] A study was made of the kinetics of gas liberation upon linear heating of specimens of $\text{Co}_{71}\text{Fe}_5\text{Si}_{15}\text{B}_9$ amorphous alloy bombarded with α particles to concentrations of 0.01, 0.1 and 1.0 at.%. Two series of specimens were studied, bombarded in the amorphous and crystalline states. Comparison of gas liberation curves and gas liberation rate spectra from the bombarded specimens which had different initial structures showed differences in the liberation rate spectra. The liberation of

helium from the material in the amorphous state was slight. The liberation rate spectra from specimens bombarded in crystalline states have a more complex structure of peak in the area of moderate temperatures, apparently related to the defect content of the structure of the crystalline lattice as a result of α -particle bombardment. In the amorphous state a peak is clearly seen at a temperature corresponding to crystallization. It was found that about 0.005 at.% helium remains in specimens bombarded with α particles at a temperature above 1225°K which is then liberated upon melting of the material. Figures 6; references 4: all Russian.
[156-6508]

COMPOSITE MATERIALS

UDC: 539.216:539.4

MECHANICAL PROPERTIES OF Be-Al COMPOSITE

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian. No 2, Mar-Apr 84
(manuscript received 28 Sep 81) pp 110-112

VOLOKITA, G. I. and PLETENETSKIY, G. Ye., Khar'kov

[Abstract] A study is presented of the possibility of producing a Be-Al layer-type composite with high volumetric content of beryllium, up to 70-80% by volume. Mechanical properties of the composite are studied. Composite materials were formed by rolling a packet consisting of five sheets of beryllium and six of AMg-6 at 723-823°K with up to 65% compression. The packet was vacuum treated before rolling. Tensile tests of the composites and components were performed at 300 and 673°K at a loading rate of 1.0 mm/min. Bending tests were performed at 300°K with a 3-point loading system, 2 mm diameter core moving at 0.2 mm/min. The best strength characteristics relative to the composite were produced with a rolling compression of 50% in a single pass. Intermediate annealing leads to an increase in relative elongation by up to 4-6% with a slight decrease in strength. Increasing deformation to 65% decreases strength and ductility, apparently as a result of the formation of microscopic cracks in the beryllium component. Ductility of the composite is 2 to 4 times greater than that of beryllium. The strength is as was calculated by the refined additive rule, indicating that the components are strongly bonded. Increasing the volumetric fraction of beryllium to 70-80% creates more favorable conditions for homogeneous deformation of the components of the composite. References 7: 4 Russian, 3 Western.
[116-6508]

CALCULATING RESIDUAL STRESSES IN COMPOSITE MATERIALS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 84
(manuscript received 14 Feb 83) pp 113-117

YEPISHIN, A. I., PIROGOV, Ye. N. and KONOPLINKO, V. P., Moscow

[Abstract] A method is presented for calculating residual stresses in fiber composites, using the model of coaxial cylinders. It is assumed that the hardening fiber is elastic, while the matrix experiences elastic, plastic and viscous deformation. Calculation is based on the theory of flow using the method of supplementary deformations, requiring preliminary solution of the elastic problem with supplementary deformations. The following positive aspects of the calculation method are noted: performance of significant analytic transforms before numerical solution, simplifying computation and increasing accuracy; use of the flow theory which allows the history of loading to be considered and a transition to be made to the study of rheologic effects such as the study of the influence of residual stresses on the first stage of creep. Figures 3; references 8: 6 Russian, 2 Western. [116-6508]

UDC: 669-494

SPREADING UPON COMPACTING OF FIBER COMPOSITE MATERIALS WITH POROUS METAL MATRIX

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 84
(manuscript received 13 Dec 82) pp 97-100

AREF'YEV, B. A., Moscow

[Abstract] The question of deformation of the matrix in the presence of fiber in a composite material produced by compression has been studied widely, but most previous works have ignored the process of deformation of the material in the direction perpendicular to the fiber -spreading. To reveal the characteristics of this process, spreading between two parallel plates was studied. Equations were derived which indicate that the spreading occurs in all stages of deformation of composites during compacting. The amount of spreading depends primarily on the parameters of the deformation focus and the design of the initial packet of matrix and fibers which is compacted. The packet includes a porous metal matrix. The length of the slip zone varies significantly. As relative porosity decreases there is an increase in the length of the slip zone, while an increase in volumetric fiber content also causes an increase in spreading. Figures 2; references 5: all Russian. [116-6508]

INFLUENCE OF VOLUMETRIC FIBER CONTENT ON SOME MATRIX DAMAGE FACTORS DURING THERMAL CYCLING OF TUNGSTEN-EI 765 COMPOSITE

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 84
(manuscript received 23 Aug 82) pp 101-105

YEREMENKO, V. I., Moscow

[Abstract] A composite consisting of the chrome-nickel alloy EI 765 plus unidirectional high-purity tungsten fibers was studied. The heating and cooling rates were the same, 2°C/s , maximum temperature 1150°K , minimum 350°K . Holding time at the maximum temperature varied from 0 to 10 hours. The composite was constantly loaded with a tensile stress of 300 MPa in all cases. Damage rates were calculated on the basis of a deformation model of accumulation of damage. During heating and cooling, creep and plastic deformation of the matrix change significantly in narrow temperature intervals, primarily near the minimum and maximum temperatures. In the area of reduced plasticity, static damage is slight and not dangerous. Increasing holding time at the maximum temperature causes an increase in almost all types of damage to the matrix, particularly static damage due to creep. When holding times and external loading the variation of durability of the matrix as a function of V_f may have a minimum due to the addition of oppositely directed deformations which depend on V_f , produced by internal thermal stresses and the external load. Durability of the matrix material increases with increasing distance from the phase boundary with the fibers. Composites with a small volumetric fraction of fibers show a particularly great difference in durability in these areas. Figures 4; references 3: all Russian. [116-6508]

UDC: 537.525:543.422.8.063

STUDY OF SURFACE DAMAGE IN CATHODE COMPOSITE MATERIALS IN A HIGH FLUX CO_2 LASER

Moscow POVERKHNOST' in Russian No 7, Jul 84 (manuscript received 15 Nov 82)
pp 107-111

GNESIN, G. G., LEVCHENKO, G. V., LUBAN, R. B., BARSUK, V. A., NESTERENKO, V. M. and FILIMONOV, M. Z., Institute of Material Science Problems, Ukrainian Academy of Sciences, Kiev

[Abstract] Composite materials for emitters based on tungsten and copper, molybdenum and copper, containing LaB_6 inclusions were tested in an LT-1 commercial high flux CO_2 laser. Electrodes were prepared by powder metallurgy methods and soldered into ceramic cathode elements with PSr-72 solder. Visual inspections were performed over the course of 2 years operation of the cathode elements. No significant changes were observed during

the first four months. However, after opening the gas discharge chamber it was found that a thin layer of film had formed on the working surfaces of all cathode elements, which was removed by diamond grinding from both emitter and ceramic. Subsequent operation of the elements for 1 year 8 months showed that they supported stable glow discharge with slight overgrowth of the emitter surface. Subsequent examination with an optical and an electron microscope showed that the products of erosion and corrosion of the emitter had been deposited both on its surface and on the surface of the ceramic of the electrode elements in the direction of movement of the gas flux. For emitters containing molybdenum the total quantity of erosion and corrosion products precipitated on the ceramic was approximately 30% less than for electrodes containing tungsten. Photomicrographs of the surfaces are presented, Figures 6; references 8: all Russian.
[156-6508]

UDC: 620.17:677-15

QUANTITATIVE ESTIMATE OF COMPATIBILITY OF FIBER COMPOSITE MATERIAL COMPONENTS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 4, Apr 84
(manuscript received 13 Sep 82) pp 22-28

ZABOLOTSKIY, A. A., Moscow

[Abstract] The purpose of this work was to develop a method for quantitative estimation of the compatibility of fiber composite material components, taking into account not only temperature and time, but also pressure in formation and use of the composites. The degree of interaction of components as various factors act on the composite materials was also estimated. A two-stage table of equations describes the characteristics of composite material states as a function of ratio of coefficients describing the activation energy of processes and empirical coefficients. Equations describe the effects of mechanical action, time and temperature as well as the degree of compatibility and interaction among components, considering the kinetic nature of the various interactions. The level of interaction varies with mechanical properties and failure mechanism of the composites. The equations can be used to estimate the potential effective properties of composites, optimal technological conditions for their production and the condition of composites produced under actual conditions. Figures 4; references 2: both Russian.
[150-6508]

STUDIES OF STRUCTURE AND MECHANICAL PROPERTIES OF CARBON-REINFORCED PLASTIC
BASED ON SPIRALLY REINFORCED FILLER

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 3, May-Jun 84
(manuscript received 22 Mar 83) pp 397-401

FREGER, G. Ye. and IGNAT'YEV, B. B., Voroshilovgrad Machine Building
Institute

[Abstract] The principle of formation of materials from spirally reinforced complex filaments and cords provides great possibilities for expanding the assortment of reinforcing fillers made of various fibers and combinations of fibers. Materials were studied based on VMN-4 carbon cord saturated with epoxy binder plus a spiral reinforcement of NSK150/2 glass fiber. The variation in degree of filling of elements of the main reinforcement with carbon fibers as a function of pressing pressure was experimentally studied. A formula is derived for calculating the degree of filling of elements of the main reinforcement. The influence of structural parameters of a reinforcement is studied. It is most desirable from the standpoint of maximum preservation of characteristics of the material in the direction of reinforcement to wind the fine filament with a spacing assuring mutual placement of each turn of the winding in intervals between turns of neighboring elements. If this condition is met materials can be obtained with degree of filling of the main reinforcement 50-60% by volume, assuring preservation of elastic characteristics of the material. Tests show that in tensile strength testing in the direction of reinforcement, materials with spirally reinforced fibers are equal to unidirectionally reinforced materials, but the strength utilization factor of the main reinforcement increases. The strength utilization factor under compressive loading is still higher. Figures 5; references 5: 4 Russian, 1 Western.
[147-6508]

THE PROBLEM OF PROTECTING THE STRUCTURE OF A PACKET COMPOSITE OF OPTIMAL
THINWALL ELEMENTS

Riga MEKHANIKA KOMPOZITNIKH MATERIALOV in Russian No 3, May-Jun 84
(manuscript received 12 Apr 83) pp 402-407

NSHINYAN, Yu. S., Institute of Mechanics, Armenian Academy of Sciences,
Yerevan

[Abstract] A study is made of the problem of finding the optimal structure for a packet of thinwall plates and shells manufactured of composite material monolayers. Optimal structures are studied, i.e., plans which optimize certain characteristics such as strength, stability, rigidity, etc. with

fixed mass and limitations on other parameters are used. The data obtained are compared with the characteristics of optimal multilayer structures allowing determination of the additional gain, which can be achieved by varying the structure. The results indicate that over a broad range of geometries for carbon-reinforced plates the optimal parameters can yield a significant gain in load-bearing capacity. Quasi-isotropic structures in the integral sense have characteristics quite close to optimal. The mathematical method suggested in this article can be used to find the thickness-variable optimal structure both in terms of strength and in terms of stability and oscillations. References 19: 9 Russian, 10 Western.
[147-6508]

UDC: 539.4:678.067

LASER RUPTURE OF COMPOSITE MATERIALS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 3, May-Jun 84
(manuscript received 10 May 83) pp 462-465

RASSOKHA, A. A., Kharkov Aviation Institute imeni N. Ye. Zhukovskiy

[Abstract] Results are presented from an experimental determination of the coefficients of reflection of laser radiation and energy of laser rupture of a number of composite materials. It is demonstrated that there is a correlation between the energy of laser rupture and material strength. The analogy between the interaction of the laser radiation pulse with a composite and a solid body with the corresponding kinetic energy and a speed much less than the speed of sound in the composite in the composite is discussed. Specimens of various composites were irradiated with a focused gas molecular laser beam and the beam of a solid ruby laser. Only results obtained with the gas laser (type LG-50) are discussed. The laser pulse energy was 0.05 J, wavelength 10.3 μm , pulse repetition frequency 15-100 Hz, pulse length not over 130 μs . Radiation was focused by a 50-mm-diameter germanium lens with a focal length of 100 mm. The laser radiation refraction coefficients were several times less than the reflection coefficients of the structural metals and alloys tested. The specific energy of laser rupture of the composite materials was several times greater than the corresponding energy for metals. Carbon-reinforced plastic and boron-reinforced plastic have anomalously high specific laser rupture energies. There is good correlation between specific laser rupture energy and strength and rigidity of composite materials with various contents of reinforcing fibers. An analogy is suggested between the interaction of radiation with the composite and the interaction of a composite with a body moving at a velocity much greater than the speed of sound. Figures 1; references 3: 1 Russian, 2 Western.
[147-6508]

BREAKING OF MOLECULAR POLYETHYLENE CHAINS BY 1.06- μ m WAVELENGTH LASER RADIATION

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 3, May-Jun 84
(manuscript received 8 Apr 83) pp 535-537

CHMEL', A. Ye., VETEGREN', V. I. and YERON'KO, S. B., Institute of Physics and Technology imeni A. A. Ioffe, USSR Academy of Sciences, Leningrad;
State Optics Institute imeni S. I. Vavilov, Leningrad

[Abstract] Results are presented from determination of the composition and quantity of decomposition products of molecular polyethylene chains produced by irradiation of specimens with a laser operating at 1.06 μ m, pulse length 12 ns. Measurements were performed by IR spectroscopy after low-pressure polyethylene films 100 μ m thick were exposed to laser radiation focused in a spot 0.1 mm in diameter. The beam was scanned over the specimen at a spacing of 0.05 mm. The concentration of C groups can be found from the IR absorption spectra. Where $E/E_* < 1$ (no macroscopic damage) the number of groups of all types increases greatly with increasing light intensity. Where $E/E_* \sim 0.8$ (near the level of development of macrodefects) the total concentration C is about $2 \cdot 10^{19} \text{ cm}^{-3}$. After $E/E_* = 1$, further increases in radiation intensity result in only slight increases in the number of terminal C groups. The concentration of middle groups changes complexly, increasing where $E/E_* < 1$, decreasing starting at about $E/E_* = 1$. The reason for this complex variation is not known. It is assumed not to be random, but rather a result of a single physical factor which should be determined. Figures 2; references 8: 7 Russian, 1 Western.
[147-6508]

STRUCTURE AND PROPERTY FORMATION MECHANISM IN MAGNETITE ALLOY-BINDER COMPOSITE

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 4, Jul-Aug 84
(manuscript received 15 Dec 83) pp 3-9

MALYSHEVA, T. Ya., ZOZULYA, V. Yu., RABINA, P. D., KUZNETSOV, L. D.,
DOLITSKAYA, O. A., PODOL'SKIY, I. I., ALEKSEYEV, A. M. and YEFREMOV, V. N.,
Moscow

[Abstract] The purpose of this work was to establish the mechanism of interaction between magnetite alloy and potassium aluminosilicate binder during heating of a system in an oxidizing medium and to reveal the influence of the phase transformations which occur in this process on the strength and hygroscopicity of the composite produced. Specimens were prepared by mixing

granules of magnetite alloy with potassium aluminosilicate binder in a ratio of 92:8 by mass and subsequent roasting of the mixture at 550 to 1200°C. Processes of mineral formation occurring upon heating of the binder alone were first studied, followed by the system as a whole. Studies of the phase composition of the system sintered at 550°C by optical and micro x-ray spectral methods showed that the composition and microstructure of the magnetite granules remained unchanged in comparison to unroasted granules. Comparison of mineral formation processes at 550 and 1100°C indicated different depths of interaction between the components. At 1100°C, the potassium, silicon, calcium and iron in the binder and magnetite alloy granules diffuse into each other. Specimens sintered at 550 to 1000°C with only superficial mineral formation reactions have relatively low strength. Specimens roasted at 1100-1200°C, with deep mutual diffusion of elements, show significantly greater strength, up to 5.2 MPa. The phase transformations which occur during roasting determine hygroscopicity, water capacity decreasing from 0.5 mass % to 0.05 mass % as roasting temperatures increase from 550 to 1100°C. Figures 3; references 9: 8 Russian, 1 Western.
[145-6508]

UDC: 669.017

IMPACT TOUGHNESS OF COMPOSITES WITH LAYERED MICROSTRUCTURE OF OT4 TITANIUM ALLOY

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA
METALLURGIYA in Russian No 3, May-Jun 84 (manuscript received 17 May 83)
pp 111-113

RODIONOV, V. N. and PESHKOV, V. V., Moscow Institute of Steels and Alloys,
Department of Metallography of Nonferrous, Rare and Radioactive Metals

[Abstract] A study was made of the fracture of layered microstructure composites of OT4 titanium alloy during impact toughness testing. Specimens with uniform and controlled volumetric content of layers with large grain plate structure were obtained by diffusion welding of sheet rolled goods 0.3 to 1.0 mm thick with finely dispersed and coarsely dispersed plate-type structures at 950°C, pressure 5.0 MPa for 60 minutes. The mechanical properties of the composites were estimated from the results of impact toughness testing. The studies showed that the fracture of titanium multi-layer composite in impact testing depends on D_k and the placement of the notch with respect to the structural layers. When a crack propagates through the uppermost layer with large grain structure and reaches the layer with finer grain structure, crack rebirth occurs. The creation of structured multilayer composites can be an effective means to control fracture toughness. Figures 3; references 6: all Russian.
[143-6508]

FIBER COMPOSITE MATERIALS WITH TITANIUM MATRIX

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 84
(manuscript received 4 Aug 83) pp 90-96

BAKARINOVA, V. I., SHORSHOROV, M. Kh., and MESHCHERYAKOV, V. N., Moscow

[Abstract] This review of Soviet and western literature on titanium-matrix composite materials hardened by high-strength and high-modulus fibers and wires discusses the technological stages involved in development of the materials, the problem of physical-chemical interactions in the materials which are thermodynamically unstable at temperatures over 700°C and the mechanical properties of the composites produced. High strength levels are observed in the longitudinal direction, with relatively high strength transverse to the fibers. An Al-B composite is found to be superior in specific longitudinal strength and specific modulus of elasticity to titanium-based materials. However, the specific transverse strength of all titanium-based composites is 2 to 4 times greater than that of the aluminum plus boron composite. Another advantage of titanium-matrix composites is their high shear strength, about 500 MPa at room temperature, 250 MPa at 540°C. Impact toughness of the composites increases with increasing volumetric content of fibers if the fibers are more plastic than the matrix, decreasing if the fibers are more brittle. Longitudinal fatigue strength of titanium and aluminum-matrix composites reinforced with boron at 10^4 cycles is similar, but at 10^7 cycles the fatigue strength of titanium-matrix composites is significantly less. Figures 5; references 28: 14 Russian, 14 Western. [116-6508]

UDC: 536.422.1

DETERMINATION OF VAPOR PHASE CONTENT WHEN METALS ARE STRUCK BY LASER
RADIATION PULSES OF VARIOUS DENSITIES

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 84
(manuscript received 8 Jul 81) pp 7-11

PILYANKEVICH, A. N., KULIKOVSKIY, V. Yu. and SHAGINYAN, L. R., Kiev

[Abstract] The vapor phase content in the products of destruction of various metals exposed to pulsed laser radiation at various densities but at constant energy per pulse is determined, as is the rate of evaporation of these metals. It was assumed that the evaporation of different metals when exposed to the same sort of radiation could be used to estimate how various thermophysical characteristics of the metals influence the effectiveness of expenditure of energy for conversion of the substance to a vapor. Two energy densities were used: $1.5 \cdot 10^6$ W/cm² and $5 \cdot 10^7$ W/cm². Metals studied included In, Sn, Al, Cu, Cr, Fe, Ti, Zr, Mo, Nb and W. At the lower energy density the depth of the crater is significantly less than its diameter and the relative content of vapor phase is higher than at the higher energy density, which produces deeper but narrower craters. A correlation was observed between the vapor phase content and the difference between the temperature of rapid evaporation and of melting of the metals. Since evaporation of metals by Shott laser pulses forms an intermediate liquid phase, pulsed laser deposition of films can be used only if macrodefects in the films do not represent a significant problem. Figures 1; references 8: all Russian. [116-6508]

DAMAGE TO BORON FIBERS DURING THERMAL CYCLING AND ANNEALING

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 84
(manuscript received 26 Nov 81) pp 106-109

YERASOV, V. S., PIROGOV, Ye. N., KONOPLINKO, V. P., NIKESHICHEVA, Ye. V.,
TSIRLIN, A. M., SHCHETILINA, Ye. A. and BALAGUROVA, N. M., Moscow

[Abstract] Results are presented from studies of the effect of thermal cycling and annealing on the strength and fractographic characteristics of boron filaments. Uncoated boron filaments 96 and 137 μm in diameter were tested, as well as filaments with coatings of silicon carbide 98 and 145 μm in diameter, and filaments with boron carbide coating 143 μm in diameter. Carbide coating thicknesses were 2-2.5 μm . Thermal cycling and annealing were performed in a thermostat allowing maintenance of the maximum cycle temperature and annealing temperature with an error of $\pm 10^\circ\text{C}$. Heat treatment in air was performed in closed aluminum foil packets, and in a vacuum, sealed quartz ampules. Fibers were cycled between 77 and 293°K in air, 293 and 623°K in air and in a vacuum, 77 and 623°K in air. Heating and holding times averaged seven minutes. Strength loss of the fibers during annealing and thermal cycling in air is related to corrosive processes which occur more rapidly during thermal cycling. The silicon carbide or boron carbide coatings decrease the negative influence of tempering and thermal cycling by decreasing the rate of corrosion on the surface of the fiber. Figures 2; references 5: 3 Russian, 2 Western.
[116-6508]

TEMPERATURE VARIATION OF LASER MIRROR STABILITY CRITERIA

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 84
(manuscript received 20 Jul 83) pp 139-141

KOSHELEV, S. B. and KHARITONOV, V. V., Moscow

[Abstract] Permissible light fluxes on laser mirrors are determined as a function of mirror temperature in the range from 4°K to the melting point. It is shown that cryogenic mirrors operating in both steady and pulsed modes can withstand greater thermal loads than mirrors at room temperatures. Determination of the maximum permissible thermal load of initially cold mirrors, heated by radiation, requires numerical solution of the heat conductivity and thermoelasticity equations of the mirror material, a medium with variable physical properties. The admittedly qualitative results obtained in the present calculation confirm that cryogenic mirrors have an advantage from the standpoint of permissible light flux when operating in pulsed conditions. Figures 2; references 8: all Russian.
[116-6508]

EXCITATION MODES AND PARAMETERS OF STRESS WAVES IN METAL EXPOSED TO SINGLE LASER PULSES

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 84
(manuscript received 26 Nov 82) pp 23-27

AVERIN, V. I., AVROV, A. I., GROMOV, B. I., YEROFEYEV, M. V., KALIN, A. A.
and LEONT'YEV, I. A., Moscow

[Abstract] A study was made of four modes of excitation of pulsed stresses using transparent and absorbing coatings. Laser radiation was focused in a 5-mm-diameter spot on specimens of annealed D16T aluminum alloy 15 mm in diameter and 1 to 20 mm thick. The stress-wave profile was recorded by quartz piezoelectric plates 5 mm in diameter and 0.3 mm thick. The dimensions and characteristics were selected to yield waves with minimal distortion. Three types of coatings were studied. A thin layer of black enamel, a thick glass plate and their combination. It was found that the combined use of the rigid barrier and volatile nontransparent coating on the surface of the metal increased the amplitude of the stress pulse excited. The waves propagate as elastic longitudinal waves. Figures 2; references 19: 11 Russian, 8 Western.
[116-6508]

FERROUS METALLURGY

FERROUS METALLURGY HAS NEW RAW MATERIALS BASE

Ukrainian RABOCHAYA GAZETA in Russian 6 Sep 84 p 2

[Article: "New Base of Metallurgy"]

[Text] Ferrous metallurgy will receive a new raw materials base. Along the Sea of Azov, the Ukraine's fifth iron-ore region with total reserves of more than 4 billion tons has been explored.

As reported to the correspondent of the RATAU [Radio and Telegraph Agency of the Ukraine] in the Ukrainian SSR Ministry of Geology, the deposits of the region along the Sea of Azov consist of three fields--the Mariupol'skoye, Kuksungurskoye and Gulyaypol'skoye. The first is located only 20 kilometers to the West of Zhdanov, to whose metallurgical combines--"Azovstal'" and imeni Il'yich--raw materials have to be brought hundreds of kilometers from Krivoy Rog, Kremenchug and Kerch.

The Kuksungurskoye Field is located 60 kilometers farther to the west. Its ores are distinguished by a high iron content, which makes it possible to use them to produce raw material for powder metallurgy. The largest of the fields, Gulyaypol'skoye, is located at an equal distance from the metallurgical combines of Zaporozh'ye and Zhdanov.

The upper levels of the new iron-ore region begin at a depth of from 5 to 180 meters, which makes it possible to work them using the more economical open method--with the help of powerful excavators and other modern equipment. Tests of the composition of the ores have shown that they can be enriched easily and that means that from them one can obtain rich concentrate or fluxed nuggets that increase the productivity of the blast furnaces.

9746

CSO: 1842/019

HEAT TREATMENT

NEW METHOD FOR HEAT TREATMENT OF METALS

Frunze SOVETSKAYA KIRGIZIYA in Russian 23 Sep 84 p 3

[Article by Boris Goldberg: "Fantastic Cold Shock"]

[Text] Journalist Boris Goldberg tells about an invention that seems amazing: a new method for the heat treatment of metals. The author of the invention is Yelena Zhmud', a graduate of Rostov University.

A steaming receptacle with liquid nitrogen. Its steel walls are covered with frost. The temperature in the receptacle is minus 196 degrees Celsius. And suddenly the heat treatment specialist pulls a white-hot chisel out of the oven and lowers it into this super-cold liquid, just as he is accustomed to immersing a tempered instrument into hot oil. Columns of vapor over the vessel and within a bundle of fire. There is a powerful cold shock like an explosion, and it seems amazing that the hot metal is able to withstand it.

"I carried out the first experiments myself," relates Yelena Zhmud', "the men refused. For this temperature combination of minus 196 and plus 1,260 degrees seems very unfriendly."

The future inventor studied in the physics and mathematics department at Rostov University. It was not until the fifth course that she took an interest in the heat processing of cutting tools. She made that her diploma project when the graduates were offered the opportunity to try out their strengths in physics and mathematics for realistic production purposes at "Rostsel'mash," the very large plant for agricultural machine building. Yelena Zhmud' delved into the scientific literature....

The freshness of perception was telling. The student was interested by the fact that tempering does not at all cease when the component cools down to room temperature but can continue if it is cooled further. A.P. Gulyayev, a well-known scientist and metals expert who advised the diploma candidate, recommended increased tempering of the tool by cooling it to minus 80 degrees Celsius. But he advised doing that very carefully and gradually, so that the metal does not break apart from the abrupt cooling. But Lena paid no attention to these recommendations, and she boldly took charge of things with all of her enthusiasm as a student.

The plant management did not expect any particular benefit from the diplomas in physical mathematics, but it treated the diploma candidates benevolently: "Do any experiments you want as long as they do not go against our safety techniques." When the student Zhmud' situated herself by the thermal oven and put a steaming vessel of liquid nitrogen down next to it so that she could plunge an incandescent chisel into it, they took the vessel and the tool away from her. And the heat treatment specialists laughed as if to say: she wanted to blow us up and freeze us.

But Yelena did not abandon her idea. She stayed in the shop after the shift and arranged things with a supply clerk, a girl just as young as herself, and worked through everything just as she had planned. The next day, the experienced heat treatment specialists and the management had nothing to laugh about. The tool that she had subjected to cold shock processed 1,000 components of super-hardened steel instead of the standard 10 without being resharpened! The results of the experiment turned out to be so unbelievable that in the diploma project the phrase "tool resistance increased by 100 times" was changed to the more modest "by several times."

The young physicist is soon assigned to work in the small town of Fryazino near Moscow, where she continues her research. Yelena Zhmud' is joined by engineers-metals experts surprised by the results. A voluntary research group carries out hundreds of experiments. The cold-processed instrument undergoes double testing--under the metallographic microscope and directly in work. And the shop foremen confirm that the resistance of the cutting instrument is increased by 20, 30, 50, 100 times. An invention claim went to the State Institute for Patent Appraisal.

It happens in science that, along with the most complicated experiments and analyses, some well-accepted certainty remains unverified. That is what happened this time too. Since it is assumed that the hardness and resistance of a tool increase simultaneously, and the latter increased every time, they did not check the hardness. When they finally did decide to measure the hardness of the tool prior to and after the cold processing, it turned out that it did not change at all, even though resistance increased by several dozen times. Here it can truly be said that "the more we know, the less we know."

Yelena Zhmud' decided to tell A.P. Gulyayev about this paradox. He had doubts about her report and asked that the experiment be performed in his presence. Becoming convinced of the unusual effectiveness of the proposed method (this time the resistance of the tool increased by 30 times), Gulyayev evaluated the invention of Yelena Zhmud' as one having great significance for the national economy. He specified several original experiments to explain these astonishing results.

Meanwhile, processing through great cold has opened up more and more new possibilities. It has turned out that in a number of cases one does not have to heat the tool at all before immersing it in liquid nitrogen. Here, for example, is a method that can be introduced literally today at any plant. One only needs liquid nitrogen, a tool and the will. You take an ordinary chisel and immerse it in liquid nitrogen for 10 minutes. Once the frost has melted from the

handle, put the chisel on the bench and work with it as if it were made of diamond. Or take the blade of a handsaw, but before fastening it dip it in liquid nitrogen and for a long time it will not need to be replaced. Drills, punches, countersink bits and screwdrivers acquire surprising resistance. Even an ordinary kitchen knife will not need sharpening for months after being in liquid nitrogen.

After the results of the work of Yelena Zhmud' and her colleagues were published in the scientific literature, the only way to satisfy the interest that had suddenly arisen everywhere was to organize a press conference. The country's largest plants sent their representatives to meet with the inventor. Yelena Zhmud' took from her handbag a kitchen knife with an attached thin copper wire.

"This knife was in liquid nitrogen today," said the inventor, "I brought it as a gift to the author of the article that for the first time told about our invention. I hope that it will work for several years without being sharpened."

This astonishing simplicity of a method that requires neither capital investment nor reequipping of tool production has produced a chain reaction of assimilation. A year did not pass before the invention of Ye. Zhmud' began to be used at many industrial enterprises of the country. It has already saved several million rubles.

9746
CSO: 1842/015

MECHANICAL PROPERTIES

UDC: 535.211

INFLUENCE OF LASER HARDENING ON MECHANICAL PROPERTIES OF TYPE 45 STEEL WITH VARIOUS PRELIMINARY HEAT TREATMENTS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 84
(manuscript received 29 Nov 82) pp 12-17

VELIKIKH, V. S., KARTAVTSEV, V. S., ROMANENKO, A. V. and TEREENT'YEV, V. F.,
Moscow

[Abstract] Laser hardening of the surface layer of metals results in a significant increase in fatigue durability and endurance limit. This work studies the influence of laser hardening on the mechanical properties of type 45 steel with various preliminary heat treatments in tensile, fatigue and wear tests. The structure and distribution of residual stresses in the surface layer after laser hardening are also studied. Pulsed laser hardening was performed on a "KVANT-18" installation in air with a laser pulse energy of 85 J, hardening spot diameter 7 mm, pulse length 8 ms. The laser hardened layer was 100 μm deep. Hardening was also performed with a CO_2 laser with a radiation power of 500 W, producing a hardened layer 150 μm deep. Pulsed laser hardening following thermal hardening plus tempering at over 400°C is found to cause an increase in tensile strength, but a decrease in tensile strength results in metals which were tempered at less than 400°C. CO_2 laser hardening forms residual compressive stresses in the surface layer and increases the fatigue limits for normalized type 45 steel specimens by 14%. Figures 4; references 6: 5 Russian, 1 Western.
[116-6508]

STRENGTH AND FAILURE OF CERAMIC-METALLIC MATERIAL

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 84
(manuscript received 19 Aug 82) pp 118-123

BARINOV, S. M., IVANOV, V. S. and KRASULIN, Yu. L., Moscow

[Abstract] This work continues a study of the relationship of mechanical properties of cermets with their structure. Comparative studies are presented of the fracture toughness, deformation, strength and thermal stability of the cermets $\text{LaCrO}_3\text{-Cr}$ obtained by high-speed (explosive) and static pressing of powder mixtures with subsequent sintering. The temperature variation of mechanical properties of the cermet 60% $\text{LaCrO}_3\text{-40% Cr}$ were studied in the 20-1200°C interval. The relative density of the material produced by explosive pressing was 96%, by static pressing - 91 - 92%. Beam specimens measuring 3 x 5 x 40 mm were loaded in 3-point flexure in an atmosphere of argon, traverse movement speed $8 \cdot 10^{-6}$ m/s. Thermal stability testing was performed by subjecting cylindrical specimens 10 mm in diameter and 20 mm high to thermal shock at 20-2150-20°C, cooling in air at 300°C/min. The studies showed that the specific organization of the structure of cermets produced by high-speed pressing significantly increases deformation, strength, fracture toughness and thermal stability of the material. Figures 4; references 12: 9 Russian, 3 Western.
[116-6508]

OBITUARIES

V. S. MATVEYEV (OBITUARY)

Moscow VECHERNYAYA MOSKVA 4 Oct 84 p 4

[Text] Vladimir Sergeyevich Matveyev, head of a department of the State Scientific Research and Design Institute of the Rare Metals Industry, has died suddenly. He was a member of the Communist Party of the Soviet Union.

The death announcement is made with deep regret by the Oktyabr'skiy Rayon Committee of the Communist Party, the USSR Ministry of Nonferrous Metallurgy, and the institute, and condolences are expressed to the family and friends of the deceased.

FTD/SNAP
CSO: 1842/014

M. P. ARBUZOV (OBITUARY)

Kiev PRAVDA UKRAINY 14 Oct 84 p 4

[Excerpt] Doctor of Physical-Mathematical Sciences, Professor Moisey Petrovich Arbuzov, an eminent scientist in the field of metal physics and head of a department of the Ukrainian Academy of Sciences' Institute of Materials Science Problems, died on October 11, 1984, at the age of 76. He was a corresponding member of the Ukrainian Academy of Sciences and a member of the Communist Party of the Soviet Union since 1946.

After graduating from Tomsk State University in 1934, he began his working career at the Kuznetsk Metallurgical complex, and he taught at Dnepropetrovsk State Univeristy.

From 1941 to 1947, he served as head of a department at a machine building plant in Sverdlovsk Oblast, and as a docent of a chair of instruction of the Khar'kov Mechanics and Machine-Building Institute and subsequently of the Kiyev Technological Institute of the Food Industry. From 1947 to 1955, he served as a senior science associate and deputy director of the Ukrainian Academy of Sciences' metal-physics laboratory, and subsequently as a professor and head of a chair of instruction of the Kiyev Institute of Civil-Aviation Engineers.

M. P. Arbuzov headed a department of the Ukrainian academy's Institute of Materials Science Problems from 1962 to the last days of his life.

His works contributed substantially to the formation of modern notions of processes for the hardening and tempering of steel and found broad practical application.

He was awarded the order of the Red Banner of Labor and medals.

(The obituary is submitted by the Presidium of the Ukrainian Academy of Sciences and the academy's Department of Physical-Technical Problems of Materials Science and Institute of Materials Science Problems.)

FTD/SNAP
CSO: 1842/014

UDC: 534.282:539.62

STATIC AND CYCLIC STRENGTH OF UNIDIRECTIONALLY REINFORCED MATERIALS IN BENDING (REPORT I)

Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 84
(manuscript received 1 Mar 83) pp 65-67

UTKIN, V. S., SALIBEKOV, S. Ye., and SAKHAROV, V. V., Vologodskiy Polytechnical Institute

[Abstract] A study was made of the material AD33-V, reinforced in one direction with boron fiber about 50% by volume. Tests were performed on flat rectangular specimens 15 mm wide, 1.5 mm thick and 36 mm long. One batch of specimens was preliminarily deformed by cyclical pure symmetrical flexure. It was found that accumulated damage had practically no effect on the static strength of AD33 composite air. The endurance limit for $2 \cdot 10^5$ cycles was found to be 0.5-0.55 times the tensile strength. Figures 4; references 2: both Russian.
[142-6508]

UDC: 621.769:621.762.4

ANISOTROPY OF ROLLED PRODUCTS OF MATERIALS ROLLED FROM GRANULES

Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 84
(manuscript received 28 Jun 82) pp 48-52

GORBUNOV, Yu. A., Krasnoyarsk Institute of Nonferrous Metals

[Abstract] Anisotropy is virtually unavoidable in rolled semifinished goods. Even when granules of A99 aluminum are rolled, anisotropy of strength and ductility properties is observed from room temperature almost up to the melting point. The forces of friction acting on the surface of the rolls cause granules to be stressed by a factor of 3.5 to 4.5 in the rolling direction, producing intensive shear in planes parallel to the rolling planes and assuring strong welding of the particles. Since the deformation of the granules is great, mechanical and crystallographic texture is important in the formation of anisotropy. The temperature of the deformation focus largely

determines the temperature of the granules and the rolling speed, which influence heat transfer to the rolls. Even when thin sheets are rolled, their properties vary through their thickness. This results from the variation in shear stress through the thickness of the rolling focus, caused by friction between the granules and the rolls. Introduction of 1.5% Mn to the aluminum (alloy AMts) has practically no influence on the anisotropy of mechanical properties, although it does increase strength somewhat. Introduction of 1.5% Cr and 1.5% Zr (alloy 01419) increases strength and ductility. Tests on stampability of rolled products from granules have shown that proper selection of thermomechanical conditions of formation and subsequent rolling of blanks can produce materials with characteristics similar to those of rolled products produced from ingots. Figures 3; references 4: all Russian.
[142-6508]

UDC: 621.762

MECHANICAL PROPERTIES OF TITANIUM-NIOBIUM CARBONITRIDE CERMETS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 84
(manuscript received 30 Jun 82) pp 33-36

ORDAN'YAN, S. S., MASKHULIYA, L. G., PANTELEYEV, I. B. and PERSININ, S. A.,
Leningrad Institute of Technology

[Abstract] A study was made of the variation in strength characteristics of group IV transition metal carbonitrides alloyed with carbides or group V metal nitrides. A complex solid solution of titanium-niobium carbonitride was preliminarily synthesized to a homogeneous equilibrium state and then crushed. The calculated quantity of binder metal was added as elemental powders, the mixture was vibration ball milled in ethanol and the plasticized charge was used to press experimental specimens for mechanical testing. The studies showed that the high-temperature strength properties of the new cermet are superior to standard type KNT. The material is thus promising for use in the manufacture of tools. Figures 3; references 8: 7 Russian, 1 Western.
[142-6508]

OPTIMIZATION OF PRODUCTION OF COMPOSITE DIAMOND-CONTAINING MATERIALS USING TITANIUM CARBIDE-STEEL ALLOYS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 84
(manuscript received 23 May 83) pp 21-25

NARVA, V. K., LOSHKAREVA, N. S., AKHMEZDYANOVA, A. M., SIMKIN, E. S.,
SKLYAR, S. I. and TSYPIN, N. V., Moscow Institute of Steels and Alloys

[Abstract] A study was made of the possibility of producing diamond-containing material with titanium steel binder instead of the normal composite diamond-containing material based on hard alloy. Charges containing 10, 30 and 40% TiC with steel binder types Kh6V3M and 5Kh6VM2 were prepared with both natural and synthetic diamonds by hot pressing and sintering in a high pressure chamber and in a vacuum. The quality of sintered specimens was monitored on the basis of density and wear resistance. Best results were obtained with hot pressing of alloys containing 10% TiC. Increasing the quantity of carbide resulted in extrusion of steel binder through the graphite mold, increased porosity and decreased wear resistance. Heat treatment was found to have a slight, at times negative, influence on the hardness of materials sintered in the high pressure chamber. When vacuum sintering was used, the best results were obtained for alloys with 40% TiC. High pressure chamber sintered materials were harder than those sintered in a vacuum. The vacuum sintered materials had the greatest wear resistance. The properties obtained were equal to those of tungsten group hard alloy-based materials. Figures 5; references 6: all Russian.
[142-6508]

UDC: 621.762.86:669.295:669'4'6'73'76

KINETICS OF SATURATION OF POROUS TITANIUM WITH LOW-MELTING-POINT METALS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 84
(manuscript received 21 Jan 83) pp 14-16

YENEVICH, V. G., KARPINOS, D. M., SAPOZHNIKOVA, A. B., TUCHINSKIY, L. I.,
Institute of Material Science Problems, Ukrainian Academy of Sciences

[Abstract] Experiments were performed on specimens 10 mm in diameter and 120 mm in length made by pressing and sintering of type-PTS titanium powder. The porosities of the specimens were 22, 33, 50, 67 and 76%. Saturating metals included bismuth, lead, tin and Wood's alloy. The specimens were saturated in a medium of dry argon. Depth of penetration was judged from the increase in weight of the saturated specimen. In Ti-Bi, saturation occurs but the significant stresses which arise upon cooling of saturated specimens leads to deformation and rupture. In Ti-Pb, Ti-Sn and Ti-Wood's alloy spontaneous saturation occurs. These three alloys can be produced over a wide range of concentrations of the components by capillary saturation.

Processes of physical and chemical interaction of the components in contact greatly influence the parameters of saturation. Figures 3; references 9: all Russian.
[142-6508]

UDC: 621.762:621.793

INTERACTIONS IN Ti-Bn POWDER COMPOSITES

Kiev POROSHKOVAYA METALLURGIYA in Russian No 4, Apr 84
(manuscript received 16 Jun 83) pp 18-22

BORISOVA, A. L., BORISOV, Yu. S., SHVEDOVA, L. K. and MARTSENYUK, I. S.,
Institute of Material Science Problems, Ukrainian Academy of Sciences

[Abstract] A study is presented of the interactions in Ti-Bn powder mixtures during heating, hot pressing and heating in a high-temperature gas medium. The results obtained are used to select compositions and conditions for application of coatings of Ti-Bn powders. Interactions were studied by high temperature differential thermal analysis and metallographic, x-ray phase, microdurometric and microscopic x-ray spectral analyses. Coatings formed by interaction of Ti+Bn during heating in a gas jet were found to be of a heterophase system. The matrix is formed of a solid solution of boron and nitrogen in titanium and is hardened by titanium borides and nitrides. It also contains residual boron nitride inclusions. Figures 5; references 7: 6 Russian, 1 Western.
[150-6508]

UDC: 621.793.7

ANTIFRICTION PROPERTIES OF GAS THERMAL COATINGS OF CLAD CARBIDE POWDERS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 6, Jun 84
(manuscript received 20 May 83) pp 45-47

BORISOV, Yu. S., GELEYSHVILI, T. P., GORBATOV, I. N., MOLYAR, A. G.,
KUL'GAVYY, E. A. and POLISHCHUK, I. Ye., Institute of Material Science
Problems, Ukrainian Academy of Sciences

[Abstract] A study is made of the antifriction properties of atomized coatings on VT-22 titanium alloy. Atomization was performed with carbides of titanium and chromium clad with cobalt, copper or nickel. Cladding was performed by the autoclave method by reducing copper, cobalt and nickel from a solution of their salts with hydrogen under pressure. The clad coating thickness was 3 to 5 μm . Electrolytically chrome plated titanium alloy and coatings of oxides were also tested for comparison. The structure of the coatings after atomization consisted of carbide particles uniformly distributed in a metal matrix. In friction the coatings worked in well, at

relatively low coefficient of friction and slight wear. The most effective antifriction properties, minimum wear and minimum coefficient of friction were achieved in coatings of composite TiC-CO and TiC-Cu powders. Figures 3: references 1 Russian.
[140-6508]

UDC: 621.7.04+621.762.04

NEW METHODS OF PRODUCING FLAT PARTS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 6, Jun 84
(manuscript received 12 May 83) pp 18-21

SILIN, N. A., LOZHECHNIKOV, Ye. B., PROSYANYUK, V. V., GROMOV, V. B., MAKSIMOV, N. N., YURCHENKO, Yu. N. and DZHANGIRYAN, V. G., Central Scientific Research Institute of Scientific and Technical Information

[Abstract] The process of stamping goods from sintered rolled products has a significant shortcoming related to the difficulty of converting the wastes produced back into the initial powder. When unsintered blanks are stamped the wastes produced can be easily restored to the initial powders. Full recovery of the properties of powders produced by grinding of wastes requires roasting, which is not always possible. A method has been developed for the production of thin flat blanks by rolling of powders into porous strips and subsequent compacting between a flat barrel and a plate or between rolls with shaping elements. It is then easier to separate the uncompacted powder from the compacted formed products. A diagram of the process is presented, along with photographs of the strips of porous powder with compacted formed parts and the parts after the uncompacted powder has been separated and returned for reuse. Factors which affect the dimensional accuracy of the products are analyzed. Figures 3; references 7: all Russian.

[140-6508]

UDC: 621.762

USE OF ULTRADISPERSED POWDERS OBTAINED BY PLASMOCHEMICAL METHODS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 6, Jun 84
(manuscript received 8 Apr 82) pp 1-7

SHEVCHENKO, S. A., LEVLYUK, L. P. and PAVLOV, S. M., State Institute of Applied Chemistry

[Abstract] This literature review discusses the production and use of very finely dispersed powders produced by plasmochemical methods. The production of these powders in a stream of reagents in a low-temperature plasma has been performed for 15 years. However, there are certain difficulties in technological

mastery of the potential advantages of plasma powders. The problem of passivation requires special solution, and further processing by powder metallurgy methods is difficult. The data presented in this work, gleaned from both Soviet and western sources, indicate broad capabilities of the plasmachemical method for production of ultradispersed powders. These capabilities result not only from the good productivity of the method, but also from the fact that a special class of materials is created, the special properties of which are in many cases unique and allow new areas of application in the economy. References 58: 53 Russian, 5 Western.
[140-6508]

UDC: 621.762

INFLUENCE OF TEMPERATURE ON WEAR RESISTANCE OF DETONATION COATINGS OF ALLOY POWDERS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 4, Apr 84
(manuscript received 27 Dec 82) pp 37-46

NOSOVSKIY, I. G., SHCHEPETOV, V. V., KADYROV, V. Kh. and KOTLYARENKO, L. A.,
Institute of Material Science Problems, Ukrainian Academy of Sciences;
Kiev Higher Military Aviation Engineering School

[Abstract] A study was made of the effect of temperature on regularities of friction and wear of processes in tungsten-free wear-resistant coatings atomized by the detonation-gas method. Specimens atomized with type VK15 hard alloy powder were also used to provide a comparison of friction and wear characteristics. Detonation coatings of nichrome alloy powder showed the least wear. X-ray phase analysis at 600°C and higher revealed the presence of Cr_2O_3 , CrO_3 , NiO and NiCr_2O_4 spinel, which improves the protective properties of the oxide film. The results of the testing showed good operational characteristics in comparison to traditional hard alloys. The coatings can be used in dry friction couples at elevated temperatures. Figures 4; references 2: both Russian.
[150-6508]

METHOD OF DETERMINING THERMAL STABILITY OF HEAT-RESISTANT COATINGS ON GRAPHITE

Kiev POROSHKOVAYA METALLURGIYA in Russian No 4, Apr 84

(manuscript received 14 Oct 82) pp 35-37

ALEKSEYEV, V. V. and LOSKUTOV, V. S., Scientific Research Institute of Introscopy

[Abstract] A study was made of the possibility of producing a thermally stable coating by plasma atomization to be used as an object for testing thermal stability of a rapid method for preliminary selection of coating materials. Experiments were performed on cylindrical specimens of V-1 graphite 40 mm in diameter and 5 mm long. Sharp edges were blunted to a radius of 1 mm. The coating material consisted of powders of the metal and their compounds with particle sizes between 63 and 100 μm . Coatings were applied by plasma atomization in air to the end of the specimens. Thermal stability was determined with plasma equipment in a special laboratory installation. The results were evaluated visually during thermal cycling. A thermal stability diagram was constructed for the various coatings. Figures 2; references 2: both Russian. [150-6508]

UDC: 621.762.5:620.1.539.4:536.2

BEHAVIOR AND SPECIFICS OF FRACTURE OF POROUS FIBER MATERIALS IN EXTENSION

Kiev POROSHKOVAYA METALLURGIYA in Russian No 7, Jul 84

(manuscript received 26 Jul 82) pp 83-86

KOSTORNOV, A. G. and GALSTYAN, L. G., Institute of Material Science Problems, Ukrainian Academy of Sciences

[Abstract] Experiments were performed on specimens obtained by directional pressing and high-temperature sintering after liquid matting to decrease the influence of structural heterogeneities on strength. Tests were performed at room temperature at loading rates of 10 to 25 mm/min. Deformations were measured with foil tensoresistors. It was found from tests of nichrome fibers that beyond the limits of elasticity, Young's modulus of porous fiber materials can be considered practically constant. Tensile testing diagrams of specimens with various porosities were used to establish the ultimate tensile strength and relative elongation of materials made of copper, nickel, chrome and stainless steel fibers of various diameters. The tensile strength was found to vary primarily with fiber strength and quality of contact between fibers, contact quality playing a decisive role. Improving contact quality from 70-85% of ideal to 80-95% of ideal in nichrome and from 60 to 65% in stainless steel can increase the relative strength by 1.3-2.5 and 2.5-2.8 times.

Great plastic deformations were observed as a result of the rigid-flexible bonding between particles. Due to the large numbers of contacts per fiber material particle, strength is much greater than for powder materials, this difference increasing with increasing porosity. Figures 3; references 3: all Russian.
[142-6508]

UDC: 620.193.55:669.15

INFLUENCE OF GASEOUS HYDROGEN ON STRENGTH AND DUCTILITY OF NICKEL HEAT-RESISTANT ALLOYS

Kiev FIZIKO-KHIMICHESKAYA MEKhanika MATERIALOV in Russian Vol 20, No 3, May-Jun 84 (manuscript received 24 May 83) pp 53-56

MAKSIMOVICH, G. G., KHOLODNYI, V. I., BELOV, V. I., TRETYAK, I. Yu., IVAS'KEVICH, L. M. and SLIPCHENKO, T. V., Institute of Physics and Mechanics imeni G. V. Karpenko, Ukrainian Academy of Sciences, L'vov

[Abstract] The purpose of this work was to establish the regularities of the influence of gaseous hydrogen on the mechanical properties of heat-resistant nickel alloys in various structural states in the 290-1073°K temperature interval. Commercial vacuum-arc remelted nickel-based alloys hardened with the intermetallide γ' phase were heat treated and tensile tested at $6.7 \cdot 10^{-5} \text{ s}^{-1}$ in a high-pressure chamber. The temperature variation in characteristics of short-term strength of the alloys in a vacuum indicate that significant strength loss occurs at 873-1073°K. Embrittlement of specimens in this temperature range was caused by localization of deformations at grain boundaries, resulting from intensive redistribution of titanium, aluminum and nickel in the boundary areas, preceding the appearance of the γ' phase. In hydrogen, a slight decrease in strength and a very significant decrease in ductility of all alloys was observed, particularly at near room temperature. As the temperature increased the influence of hydrogen became less. There is a maximum on the temperature curve of relative elongation of specimens of KhN60MVYu-VD alloy at 873°K. The influence of gaseous hydrogen on nickel heat-resistant alloys is thus manifested as a significant decrease in ductility and a change in the nature of fracture from transcrystalline to intercrystalline, increasing with an increase in the quantity of hardening γ' phase and stopping altogether at a temperature of 1073°K. Figures 3; references 11: 7 Russian, 4 Western.
[141-6508]

ESTIMATION OF ENDURANCE CHARACTERISTICS OF HEAT RESISTANT MATERIALS.
REPORT 2. DETERMINATION OF ENDURANCE LIMIT OF HEAT RESISTANT ALLOYS OVER A
BROAD TEMPERATURE RANGE

Kiev PROBLEMY PROCHNOSTI in Russian No 6, Jun 84
(manuscript received 30 Nov 82) pp 71-74

POGREBNAK, A. D. and ZHELDUBOVSKIY, A. V., Institute of Mechanics, Ukrainian
Academy of Sciences, Kiev

[Abstract] The problem of accelerated estimation of the resistance characteristics of structural materials to cyclical loads, particularly determination of the endurance limit using a limited volume of experimental data, is of significant scientific interest. The problem can be solved with sufficient reliability by utilizing the method of recording changes in microhardness during the process of fatigue to investigate the durability of metals. The literature on microhardness studies in the process of metal fatigue at normal and elevated temperatures is analyzed and indicates that the change in microhardness in the process of cyclical loading of metals at elevated temperatures can be used to determine temperature range of existence of the endurance limit and the stress which corresponds to it at the test temperature. The method of accelerated determination of the endurance limit of heat resistant alloys is based on the specifics of alteration of microhardness as a function of test temperature and applied stress. Its essence is estimation of the maximum amplitude of variable stress which does not cause a decrease in microhardness below the initial value. This is achieved by gradual loading of the specimen in stages with measurement of microhardness at each loading stage. The method suggested was tested by determining the endurance limit of a group of deformed heat resistant nickel alloys under fatigue conditions. The method suggested significantly reduces the labor consumption of the determination and achieves good reliability. Figures 2; references 15: 13 Russian, 2 Western.
[149-6508]

TITANIUM

UDC: 620.172.254

INFLUENCE OF EXTENSION RATE ON STRENGTH AND DEFORMATION CHARACTERISTICS OF TITANIUM ALLOYS OVER A BROAD TEMPERATURE RANGE

Kiev PROBLEMY PROCHNOSTI in Russian No 6, Jun 84
(manuscript received 4 Jul 83) pp 92-96

TOKAREV, V. M., Institute of Strength Problems, Ukrainian Academy of Sciences, Kiev

[Abstract] Results are presented from tensile testing of OT4, VT23, VT3-1 and VT14 titanium alloys at deformation rates of 10^{-3} - 10^3 s⁻¹ at 77 to 773K, both as delivered and after heat treatment. The tests utilized specimens with shortened gage sections 4 mm in diameter and 10 mm in length. The deformation-time and force-time oscillograms produced indicate satisfactory maintenance of constant deformation rate to and beyond the yield point. Thermocouples attached to the surface of the specimens were used to determine specimen temperatures. Heat treatment is found to improve strength characteristics while decreasing ductility within the deformation rates tested at 77 and 523°K. Further increases in temperature result in decreases in the influence of hardening heat treatment. At higher temperatures there is an increase in ductility and a decrease in strength as is characteristic for steel which does not manifest deformation aging. Figures 7; references 10: all Russian.
[149-6508]

KINETICS OF OXIDATION OF TITANIUM ALLOY UPON HEATING TO 1000°C

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 20, No 3,
May-Jun 84 (manuscript received 11 Jul 83) pp 76-79

FEDIRKO, V. N. and LIZUN, A. T., Institute of Physics and Mechanics
imeni G. V. Karpenko, Ukrainian Academy of Sciences, L'vov

[Abstract] An attempt was made to estimate the effect of alloying elements on the oxidation kinetics of commercial titanium alloys upon continuous heating to 1000°C in air. The experiments were performed on the alloys VT1-0, OT4-1, PT7-M, VT5-1, VT6s, VT14 and VT23. Changes of mass during heating were determined by continuous weighing on a derivatograph. Heating was performed from 20 to 1000°C at 10° per minute. The portion of the TG curve in which mass increases significantly can be divided into two parts. The first part corresponds to oxidation, during which the increase in mass is slight, while the second part reflects the relatively rapid change in mass in the stage of accelerated oxidation. The phase of accelerated oxidation begins at various temperatures for the various alloys. The temperature at which the second stage of oxidation begins can be used to characterize the heat-resistant properties of the alloys. Aluminum may either activate or inhibit oxidation during this process. The alloying elements zirconium, molybdenum and tin also increase heat resistance of the alloys in the initial stage of oxidation while manganese has practically no influence on this characteristic and chromium causes it to become significantly worse. During accelerated oxidation molybdenum, manganese, tin and zirconium help to increase the rate of oxidation, although it remains less for VT14 and PT7-M than for technical titanium. Figures 1; references 8: 7 Russian, 1 Western.
[141-6508]

STUDY OF THE VOLUMETRIC CHANGES IN VT23 ALLOY UPON HEATING

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA
in Russian No 3, May-Jun 84 (manuscript received 3 May 83) pp 87-91

IL'IN, A. A., KOLLEROV, M. Yu., NAZIMOV, O. P. and ZASYPKIN, V. V., Moscow
Institute of Aviation Technology, Department of Metallography and
Technology of Heat Treatment

[Abstract] Experiments were performed on hot rolled bars of VT23 alloy containing 5.8 mass % Al, 4.3 V, 2.1 Mo, 1.0 Cr and 0.75 Fe. All bars were annealed for 1 hour at 55°C below A_{c3} . Blanks for specimens for dilatometric and x-ray structural analysis were annealed at 700-1000°C for 1 hour, then quenched in water, cooled in air or with the furnace. Depending on the temperature to which the metal is heated, quenching in water produces

structures with various metastable phases. Analysis of dilatograms showed that for specimens cooled after annealing in air there is a small negative high-temperature volumetric effect in the 400-600°C interval. Regardless of the initial phase composition, the high-temperature negative volumetric effect results from a decrease in atomic volume of β phase due to its enrichment by alloying elements resulting from diffusion exchange with the α'' - or nonequilibrium α phase. Figures 2; references 8: 7 Russian, 1 Western.
[143-6508]

UDC: 669.2295:536.42

STUDY OF INFLUENCE OF COLD PLASTIC DEFORMATION ON AGING OF VT30 ALLOY

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: TSVETNAYA
METALLURGIYA in Russian No 3, May-Jun 84 (manuscript received 17 Mar 83)
pp 82-87

MAL'TSEV, M. V. and VOLKOVA, T. N., Gor'kiy Polytechnical Institute,
Department of Heat Treatment and Plastic Working of Metals

[Abstract] A study is made of processes of decomposition of the metastable beta phase upon aging of hardened and deformed VT30 alloy in order to determine the specifics of phase transformations occurring in cold deformed alloy in comparison to the undeformed alloy. Specimens were cut from bars hardened from 680 and 800°C, deformed in the cold state by 15% compression then aged by continuous heating to various temperatures from 200 to 550°C. X-ray diagrams of sections of the specimens were obtained after deformation, and hardness was measured perpendicular to the deformation axis. Dilatometric studies were also performed. The x-ray studies showed that the liberation of the ω phase begins at 300°C and is completed by 450°C. The ω phase disappears at 450-530°C. The α phase is formed at 510°C. Alpha-phase particles begin to be liberated at a temperature near 500°C. It is concluded that the use of deformation after hardening changes the reaction of decomposition of the β phase during aging of the alloy, suppressing the liberation of the ω phase and leading the formation of α'' -martensite. The crystalline lattice of the deformation martensite has a preferential orientation relative to the deformation axis which is preserved even when the metal is heated to high temperatures and influences dilatation of the specimens. Figures 3; references 7: 6 Russian, 1 Western.
[143-6508]

WELDING

UDC: 621.791.14.03:677.534:669.295

WELDING OF TITANIUM ALLOY GRIDS BY ROLLING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 7, Jul 84 pp 25-27

TRET'YAKOV, A. F., candidate of technical sciences, POLUSHKIN, G. P., candidate of technical sciences, KHARITONOVA, L. K., candidate of chemical sciences, BORISOV, A. Ya., doctor of technical sciences, GERTSIK, M. A., engineer and VLASOV, Ye. V., engineer

[Abstract] Experiments were performed in argon on an "Atmosfera" installation and in sealed vacuum convertors. The results of the studies of the effect of heat and deformation and composition of gas phase on the strength of wires and welded joints indicate that the most promising method of producing sheet-type porous screen materials of titanium alloys is welding by rolling in argon at 1173°K following preliminary etching. As the relative compression increases the pack of screens becomes more compact and is welded where the screens are jointly deformed, increasing strength and decreasing maximum relative elongation. Preliminary etching in hydrofluoric and nitric acids allows the production of joints with relative strength 60-75%. Figures 2; references 11: all Russian.

[138-6508]

UDC: 621.791.4.052:539.378.3:669.295:539.376

KINETICS OF JOINT FORMATION DURING DIFFUSION WELDING OF VT5 TITANIUM ALLOYS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 7, Jul 84
(manuscript received 15 Jun 83; in final form 6 Sep 83) pp 27-31

PESHKOV, V. V., RODIONOV, V. N., candidates of technical sciences, MILYUTIN, V. N. and NIKGOLOV, M. B., engineers, Voronezh

[Abstract] Results are presented from studies of the kinetics of formation of joints in VT5 titanium alloy with initial fine-grain equiaxial microstructure (grain diameter 3-5 μm) during diffusion welding in the temperature area below the temperature of the end of polymorphous transformation

(930-980°C). Experiments were performed on cylindrical specimens 15 mm in diameter and 30 mm high. Mechanical properties of the joints were determined using standard impact toughness testing specimens with V-shaped notches. Fractographic studies of welded joint fractures were performed using a scanning electronmicroscope. It was established that at constant pressure there are two areas in the temperature variation of creep rate, with a transition of about 900°C: the first area is a high-temperature area between 925 and 975°C, the second is a low-temperature area between 800 and 900°C. The first area corresponds to effective activation energy of creep 234KJ/mol, the second to energy of 134KJ/mol, probably corresponding to the activation energy of self-diffusion along the grain boundaries. It is assumed that the formation of relief without application of external pressure occurs due to the influence of stresses resulting from restructuring of the hexagonal α phase to the cubic β phase in the process of polymorphous ($\alpha+\beta$) $\rightarrow\beta$ transformation. Increasing welding time, accompanied by large scale deformations of the specimen, causes gradual accumulation of seizing sections on the surfaces on the specimen, causes gradual accumulation of seizing sections on the surfaces of the grains and disappearance of microdiscontinuities within the contact areas. Fracture then becomes tougher. The observed differences in the structure of fractures and kinetics of formation of joints in the low-temperature and high-temperature areas can be explained from the standpoint of the mechanism of high-temperature creep. Figures 8; references 9: 8 Russian, 1 Western.
[144-6508]

UDC: [62].791:669.018.4].002:061.3

CONFERENCE ON PROBLEMS OF TECHNOLOGY OF WELDING THERMALLY STABLE, HEAT-RESISTANT AND SCALE-RESISTANT HIGH-ALLOY STEELS AND ALLOYS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 7, Jul 84 pp 76-77

PINCHUK, N. I., candidate of technical sciences and CHERVYAKOVA, L. V., engineer

[Abstract] The conference was held in Kiev 16-17 Nov 83 at the Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences. Representatives of more than 70 scientific research organizations and industrial enterprises in the USSR were present. Forty-six reports were heard and discussed in the following areas: quality of welded joints; means for improving operational properties of welded joints; causes and mechanism of formation of hot cracks during welding of heat-resistant nickel and cobalt alloys; control of thermal processes in welding with forced cooling; high-temperature soldering of heat-resistant nickel alloys; welding materials; development of welding wires; new austenite-carbide seam composition; welding in ship building; automatic welding of nuclear powerplant pipes; experience in using electrodes based on nickel for repair of cast turbine parts without heat treatment; new steels and alloys; influence of directed crystallization of the structure and properties of heat-resistant nickel alloys; structure

and properties of nickel heat-resistant alloys with high niobium content; and structure and properties of centrifugally cast thin-wall pipe of stainless steel. The resolutions of the conference noted the significant successes achieved in the area of technology of welding high-alloy heat-resistant materials. The next conference is planned for September of 1985 in Nikolayevo.
[144-6508]

UDC: 620.171:621.791.052:539.4

FRACTURE RESISTANCE OF SURFACE LAYER WITH TECHNOLOGICAL DEFECTS UNDER CYCLICAL LOADING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 6, Jun 84 pp 3-5

LUK'YANOV, V. F., candidate of technical sciences, NAPRASNIKOV, V. V., candidate of technical sciences, Rostov-na-Donu Institute of Agricultural Machine Building and VASIL'CHENKO, G. S., "TSNITMASH" [Central Scientific Research Institute of Heavy Machine Building] "Scientific Production Association"

[Abstract] During the process of surfacing, defects such as slag inclusions may be formed in a clad layer. Cyclical deformations arise in the surfaced zone due to pulsations of pressure and temperature, and may exceed the yield point of the austenite material. Defects may thus initiate fatigue cracks. The method of testing large specimens in biaxial axisymmetrical flexure was used to test the fracture resistance characteristics of a surface layer under cyclical loading. Specimens of type 15Kh2NMFA steel were disks 550 mm in diameter and 30 mm thick. An anticorrosion layer of type 07Kh25N13 steel 10 mm thick was applied in three passes with a strip electrode. Artificial slag inclusion defects were made in the layer by drilling apertures 4 mm deep in the central portion after application of two layers. Analysis of the kinetics of development of fracture showed that the process of crack formation is stochastic in nature with respect to the direction of application of radial and shear stresses in the area of a group of defects and the direction of surfacing. Statistical analysis of fracture indicates that under cyclic loading with over 400 MPa stress the development of cracks from defects in the surface layer is improbable at $N=10^4$ cycles. The length of cracks at 10^5 cycles will not exceed 40 mm. The use of deformation intensity coefficient as a parameter monitoring the fracture rate allows prediction of the kinetics of crack growth in nuclear powerplant equipment. Figures 4; references 6: all Russian.
[139-6508]

FATIGUE RESISTANCE OF WELDED JOINTS OF HIGH STRENGTH STEELS PRODUCED BY ELECTRON BEAM WELDING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 6, Jun 84 p 25

ZAGORNIKOV, V. I., engineer, KOVBASENKO, S. N., candidate of technical sciences, Institute of Electric Welding imeni Ye. O. Paton

[Abstract] The results of studies of the transverse cross section of seams in steel 12Kh2N4MD showed that softening sectors characteristic for arc welding virtually do not occur upon electron beam welding. Joints were produced by horizontal single-pass welding on a type U-570 installation in sheets of steel hardened during controlled rolling. Fatigue test data indicate that joints produced by electron beam welding are quite serviceable in spite of the presence of zones with different levels of strength properties. Since fracture in fatigue testing occurred in all cases through the base metal, it is concluded that a defect free joint has fatigue resistance equal to or superior to that of the base metals. Figures 2; references 2: both Russian.
[139-6508]

ESTIMATE OF QUALITY OF ALUMINUM ALLOY SURFACE PREPARATION FOR ARC WELDING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 6, Jun 84 pp 21-23

RYAZANTSEV, V. I., candidate of technical sciences, FEDOSEYEV, V. A., engineer, YELISEYEVA, N. P., engineer and SAVOSTIKOV, A. I., engineer

[Abstract] Tests are performed of three methods of quantitative estimation of the quality of surface preparation of aluminum alloys before welding or soldering: measurement of contact resistance, potential difference for the quantity and composition of gases in the surface layer upon exposure to a laser beam. Sheet specimens of aluminum alloys 1201, 1420 and AMg6 1.2 to 6 mm thick were used in the studies. Comparison of the data obtained with x-ray studies of welded joints showed that a compressive force of 250 daN provides the most objective data for welding by fusion. The contact potential difference is suitable for estimation of the quality of surface preparation only after chemical cleaning. After brush treatment, contact resistance under the pressure mentioned above is most reliable. The content of hydrogen in the surface layer of alloys AMg6 and 1420 is 7.5 and 59 times more than for alloy 1201, which agrees with the tendency of these alloys toward pore formation during welding. Figures 1; references 4: all Russian.
[139-6508]

CALCULATION OF MODE FIELD IN ELECTRON BEAM WELDING OF VT6 TITANIUM ALLOY

Moscow SVAROCHENOYE PROIZVODSTVO in Russian No 6, Jun 84 pp 20-21

PSAREV, Yu. I., engineer, BARYSHEV, M. S., candidate of technical sciences and GERASIMENKO, A. V., engineer

[Abstract] Mathematical models of the welding mode fields, expressing the variation in fusion depth as a function of current and welding speed for optimal focusing current values were calculated in order to reduce the labor required to prepare programs for electron beam welding of VT6 titanium alloy. Models were developed for both vertical and horizontal beam welding with the PL-100 electron beam welding machine (operating distance 200 mm, constant accelerating voltage 60 kV). The equations derived allow calculation of the major parameters of welding modes for blanks of variable thickness in the 100-500 mA beam current range for welding speeds of 10 to 36 meters per hour. Photographs illustrate the macrostructure of welded joints in VT6 alloys for 45- and 95-mm-thick blanks welded at 24 meters per hour. Figures 3; references 5: all Russian.
[139-6508]

DIFFUSION WELDING WITH FORCED DEFORMATION OF HEAT-RESISTANT NICKEL-BASED DISPERSION HARDENED ALLOY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 6, Jun 84 pp 15-17

KARAKOZOV, E. S., doctor of technical sciences, TERNOVSKIY, A. P., candidate of technical sciences, SAMSONOVA, T. S., engineer, DAVID'YAN, E. V., engineer, Moscow Evening Metallurgical Institute, KHAYUROV, S. S., candidate of technical sciences and POL'KIN, I. S., doctor of technical sciences, All-Union Institute of Light Alloys

[Abstract] Specimens 6 mm in diameter and 10 mm high of a dispersion-hardened Ni-Cr-Al-W-Y₂O₃ alloy with contact surface irregularities 9-13 μ m in height after lathe working were welded in a vacuum of $1.3 \cdot 10^{-3}$ Pa. The flow stress sensitivity factor was determined as a function of deformation rate. Analysis of the results obtained showed that under conditions of diffusion welding with forced deformation of the alloy at $\epsilon=3-10\%$ the curves of the variation of $\log P$ have a characteristic Sigmoid shape with 3 clearly differentiated velocity intervals of deformation. At over 900°C, plastic deformation of the alloy is determined by mechanisms whose activation energy is significantly greater than that of self-diffusion of nickel. The proposed mechanism is bending of dispersed particles of Y₂O₃ due to creep controlled by volumetric self-diffusion. The temperature of deformation should be over 900°C for this type of welding, the deformation rate $1.7 \cdot 10^{-4}$ to $1.7 \cdot 10^{-3}$ s⁻¹,

where the values of speed sensitivity coefficient m are maximal. Figures 4: references 7: 5 Russian, 2 Western.
[139-6508]

UDC: 621.791.72.052:621.643.23:620.17

IMPACT TOUGHNESS OF SEAMS IN PIPE STEELS MADE BY ELECTRON-ARC WELDING

Kiev AVTOMATICHESKAYA SVARKA in Russian No 6, Jun 84
(manuscript received 17 May 83; in final form 15 Feb 84) pp 10-15

KOVBASENKO, S. N., candidate of technical sciences, Institute of Electric Welding imeni Ye. O. Paton, Ukranian Academy of Sciences

[Abstract] Steels of ten types were welded at two different running energies at speeds of 14 and 28 meters per hour. The beam current was selected at 10 to 15% greater than the current necessary for melting through the metal. The focusing current was such to assure through melting at the minimum angle of convergence of the walls. This technology allowed production of defect-free seams with almost parallel walls and a narrow zone of thermal influence. The microstructure was studied for all seams, hardness was measured and impact toughness determined in 55 x 10 x 10 mm specimens. It was found that chemical heterogeneity of the steels resulted in the formation of defects and dendritic liquation during crystallization of the narrow deep seams, greatly reducing impact toughness. Steels which have been remelted for refining purposes, particularly electric-slag remelted steels, are preferable for electron-beam welding. A needle ferrite structure is very desirable for the seams, guaranteeing high impact toughness without expensive alloying components in the welded metals. Figures 3; references 6: 4 Russian, 2 Western.
[148-6508]

UDC: 621.791.01:669.538.6.001.24

ENERGY COMPUTATION OF PROCESS OF ELECTRODE METAL DROP SEPARATION FOLLOWING PULSE OF EXTERNAL ELECTROMAGNETIC FIELD

Kiev AVTOMATICHESKAYA SVARKA in Russian No 6, Jun 84
(manuscript received 10 Jan 83; in final form 12 Jan 84) pp 21-25

TARASOV, N. M., candidate of technical sciences, Kharkov Aviation Institute imeni N. Ye. Zhukovskiy

[Abstract] A mathematical model has been developed which describes the process of separation of a drop of melted metal from an electrode upon application of an external electromagnetic field pulse. Analysis of the process is based on an energy approach which yields good agreement with

experimental results. Computation of the energy transmitted to the drop by the electromagnetic field allows selection of characteristics of an installation for measured separation of electrode metal droplets. Figures 4; references 8: all Russian.
[148-6508]

UDC: 621.791.052:669.715'721:621.982.001.24

COMPUTATION OF THERMAL SHOCK-FREE STRAIGHTENING CONDITIONS FOR ALUMINUM-MAGNESIUM ALLOY WELDED STRUCTURES

Kiev AVTOMATICHESKAYA SVARKA in Russian No 6, Jun 84
(manuscript received 11 Apr 83; in final form 21 Feb 84) pp 62-65

ZAIKIN, V. M., candidate of technical sciences, Leningrad

[Abstract] A refinement is presented to a computation method for determining optimal conditions of local heating and establishing the sequence of performance of the process of thermal straightening of aluminum-magnesium sheet goods as a function of the mechanical and thermal characteristics of the material and the type and magnitude of welding deformations. It is found desirable first to eliminate general bending, then straighten local deformations. The plans and conditions of local heating must be determined as a function of the type of welding deformations, thickness of the goods, mechanical and thermophysical characteristics of the material. The economic effect to be achieved from introduction of the improved thermal shock-free straightening system should be about 10,000 rubles at one enterprise, and the external appearance of the goods produced should be improved. Figures 3; references 5: all Russian.
[148-6508]

MISCELLANEOUS

NORILSK PRODUCES STRUCTURAL PANELS

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 22 Sep 84 p 1

[Article by V. Kamyshev, correspondent of the newspaper ZAPOLYARNAYA PRAVDA: "Norilsk Millionaires"]

[Text] Imperceptibly, as if in the shadow of its renowned neighbor, the Nadezhdinskiy Metallurgical Plant, a small plant for mineral-cotton products was built. But now 6 years have passed, and the collective of the new enterprise has also loudly made itself known. It recently produced the one-millionth cubic meter of insulation.

With the birth of this plant, life in the polar city became noticeably warmer in the direct sense of the word. The brigades of the housing-construction combine and the installers of energy systems stopped complaining about the lack of insulating materials, hundreds of kilometers of pipe lines are reliably wrapped up against the cold by a warm synthetic "coat," and dozens of new houses in Norilsk are protecting themselves against penetrating winds--as if through a shield--with light and solid plates. The demand for them is increasing every year, and the collective is striving to satisfy that demand.

The shift of senior foreman N. Zubov was the first to exceed the million mark.

"Our shop will produce the second million cubic meters faster than the first million," asserted Nikolay Petrovich in the name of the collective. "We now have more experience and more people, and the equipment has been broken in."

It must be said that a favorable effect on the acceleration of the work comes not only from the mechanization and automation of industrial processes, to which much attention is paid here, but also from socialist competition. The collective of Zubov's shift, for example, obligated itself in honor of the 40th anniversary of the victory over fascism to overfulfill the target for this year and to fulfill the five-month plan of the next year. Next year, during the days when the citizens of Norilsk will begin to celebrate the 50th anniversary of the day of the founding of the Mining-Metallurgical Combine imeni A.P. Zavenyagin, the full brigade of the N. Simovovaya Flow Line, which began the count on the second million cubic meters of insulation, will complete the program of the 11th Five-Year Plan.

There is a solid basis for the confidence of the senior foreman. During the 6 years of the work of the plant, there has not been a case where someone failed

to meet the shift, 10-day or quarterly target. The brigades of the mineral-cotton shop that compete among themselves are now daily overfulfilling the plans for all indicators by 5 to 7 percent.

From the very first days, the plant on the northern plateau Nadezhda was the most automated enterprise of the combine. And nevertheless, from the very beginning the plant experts began to make corrections to the project as they continued to mechanize.

"Take a look at this machine," invites shop chief N. Prikhod'ko. "Here they still take away the finished plates by hand. And here the machine for sewing the mats has completely eliminated manual labor. Instead of six people, it is now operated by two--an operator and a loading vehicle driver.

The plant managers support the innovators in a timely and tangible manner, and they help them to develop and introduce new and valuable ideas.

Two years ago, a second shop went into operation here, a shop that produces three-layer wall panels. Its collective set for itself the task of meeting the growing requirements of the construction projects of the Norilsk Industrial Region for this output. For it was not long ago that heavy wall panels were brought here from the "continent." Transport costs were an economic burden on the combine and made construction more expensive. Now many millions of rubles in state funds have been saved thanks to the Nadezhda plant.

In addition, the Norilsk panels have a number of significant advantages: the local insulation better protects buildings and installations against the arctic cold and, what is quite important, it is fire-resistant.

"It can be said that this very progressive product has produced a revolution in the construction projects of Norilsk," is how G. Sozayev, director of the plant for mineral-cotton products and metallic protective structures, evaluates the innovation. "One panel weighs only 1.2 tons, it is easy for builders to assemble, and its large area of 36 square meters makes it possible to cover wall spaces quickly."

This year the need arose to build a shop quickly for the preparation of metallurgical mixtures and reagents for the Nadezhdinskiy Metallurgical Plant, without which the enterprise cannot go into the winter. A very heavy burden lay on the builders. Here is where the collective of the shop for structural panels showed what it is capable of. The engineers and workers were able to find some reserves and in less than 1 month they doubled the output of panels.

Mineral plates come off of the plant conveyor in an endless flow. Leading specialists in the sector consider them the best in the country in their heat-insulation qualities. And deservedly so: three of the plant's products, and that is almost 50 percent of its production, have repeatedly been awarded the emblem of quality.

It is still necessary to add that Norilsk production now goes to construction projects throughout Krasnoyarsk Kray and that a new customer has recently

appeared: an ore-enriching combine in Yakutiya.

Plant engineers are looking into the near future. Mineral plates are to absorb production and other noises. That is, they will receive sound-insulating qualities.

9746

CSO: 1842/019

PODOLSK CHEMICAL-METALLURGICAL PLANT INCREASES PRODUCTION OF HIGH-PURITY SILICON

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 14 Sep 84 p 1

[Article by O. Buzuluk: "Clean Work"]

[Text] The collective of the Podolsk Chemical-Metallurgical Plant is working this year without interruptions. The increase in labor productivity here exceeds that of the plan by 2.2 percent, and the production cost has been lowered by an additional 1.5 percent. The sale of various items has exceeded the target by hundreds of thousands of rubles. The entire increase in production has been accomplished through greater labor productivity. Podolsk workers are already marking two-thirds of their products--more than foreseen by the annual socialist obligations--with the state emblem of quality.

"Well now, this is better!" said chief engineer B. Smirnov after again examining our equipment hypercritically, "you may go into the shop."

The snow-white smocks and hats and the soft boots seemed more appropriate for a medical or scientific institution than for metallurgical production. When I mentioned this to Boris Vasil'yevich, he just smiled.

"You will see. And by the way, for clarity it is worth mentioning one detail: there is only one atom of impurities to 1 million atoms of our production. One, do you understand?"

A stellar flame burned in the ovens, ingots of pure silicon were slowly pulled out, and on the control desks and tables lay moist sheets that served to pick up dust particles entering the shop. Downright sterile cleanliness!

It turns out that they maintain this cleanliness not only in the name of production but also to provide for normal working conditions for computer technology, of which more and more is appearing in this shop as well as in others. The "Redmet-15" melting furnaces are equipped with microprocessors, and most of the operations have been put under the control of the "Kremniy" automated system of managing industrial processes.

Computers have become good helpers for workers, process engineers and foremen. By way of example, let us take the "Plan" subsystem, on the shoulders of which

is the control over the implementation of the tasks of each furnace and each brigade and also the forecast for a month. What microsupplements need to be added? Which installations should be in operation and which can be shut down for preventive maintenance? What about raw materials? What needs to be done for 100-percent fulfillment of consumer orders?

Until recently, several engineers and process engineers had to spend at least 2 days to answer these and other questions. And even then the estimate was only an approximation. Now one operator handles it all in 2 hours with maximum accuracy.

"Has this had an effect on your work?" I ask V. Shevchenko, brigade leader of the foundry workers, with interest. He heads a large complex collective assuming key duties in honor of the 40th anniversary of the Victory and the 50th anniversary of the Stakhanov movement with the initiative of fulfilling the monthly tasks a day ahead of time.

"And how!" answers the brigade leader. "You might say that I experienced it myself. By specialty I am a process engineer and very often I had to work laboriously on these calculations. And frequently the foundry workers did not know what brand to refine or which alloying admixtures to order for the next smelting. A machine now handles this. I do not recall a time when it erred."

"This year alone," relates A. Zhukovskiy, chief economist for the enterprise, "we freed more than five dozen people for other work. How? We introduced more than 70 measures for the scientific organization of labor, we are extending the service zones, we are continuing to improve the brigade form of organizing labor, and we are renewing techniques and technology. In a word, we are doing all we can to justify the title conferred upon us of 'enterprise of high culture and production organization.'"

Every proposal of any interest at all that contributes to more intensive and high-quality work is being introduced into practice. V. Mikhnenko, one of the best plant process engineers, helped to obtain a particularly pure silicon with reduced expenditures. Founder-adjuster B. Platov took part in the modification of the structure of the smelting facilities, which made it possible to raise their productivity and improve the quality of the silicon.

Signs of renovation are visible everywhere at the plant. But they are most evident in the section for grinding finished products. The areas for the application of its 250 products are the most responsible: radioelectronics, cybernetics and electrical engineering.

For a long time, the cutting, grinding and polishing of products were a "bottleneck" at the enterprise. Obsolete equipment, crowded conditions, hand labor, and defective output slowed down the development of other production. Reorganization was required and they did it. Especially precise high-speed lathes (four replaced 50 of the old ones) and quality-control instruments appeared. They were able to free more than one-third of the workers from the section for related shops. And again increased labor productivity was accompanied by improved quality in the products.

The offensive against obsolete technology and processes is being conducted along a broad front. The tone here is being set by the workers of the central plant laboratory for automation, mechanization and measurement. Its director, L. Kubyshevskiy, acquainted me with the plans for the near future:

"We are expanding the possibilities of our automated production-control system. After the introduction of electronic computers of a new generation in the coming months, the subsystems "Deliveries," "Warehousing" and "Wages" will join its subsystems "Plan," "Cutting," "Admixtures," "Foreman" and "Process Engineer." We are bringing each new machine, installation and machine tool into the sphere of the controlling computer technology. And noteworthy is this: whereas before foundry workers, systems workers and grinders looked upon our work skeptically, we are now being besieged by benevolent helpers."

Not without reason, specialists are also counting on such help in the assimilation of the capacities of a new building wing for metallurgy, the construction of which is being completed. It will make it possible to double the output of monocrystalline silicon. Everyone who comes to this wing to work at the furnaces and installations will already be trained and will have mastered the advanced methods of the work. And they hope to assimilate the new production ahead of schedule, in time for the anniversary of the Stakhanov Movement.

9746

CSO: 1842/17

'5000' THICK-SHEET MILL DESIGNED FOR LENINGRAD'S IZHORA PLANT

Moscow IZVESTIYA 16 Oct 84 p 1

[Article by N. Lisoenko, correspondent]

[Text] Kramatorsk--The designing of a "5000" thick-sheet rolling mill, which will be the country's largest, has been completed at the "Novokramatorskiy Machine Building Plant" Association.

This mill has no counterparts in Soviet metallurgy.

Hot-rolled steel sheet 5 meters wide will roll off the mill's six-high stand.

The "5000" mill, whose construction already has begun and which will be completed early in the next 5-year plan period, is intended for the "Izhora Plant" Association of Leningrad.

FTD/SNAP

CSO: 1842/014

GOSSTANDART'S NEW CENTER FOR INFORMATION ON MATERIALS

Moscow EKONOMICHESKAYA GAZETA No 36, Sep 84 p 8

[Excerpt] When a new machine is being designed and prepared for production, where can its developers get reliable information on the composition and properties of materials and their technical and economic characteristics, so that they can use the materials which will make their machine more reliable and economical? All such data will be gathered at the recently created All-Union Scientific Research Center for Materials and Substances (VNITS MV) of the State Committee on Standards (Gosstandart). New materials and ones that are already being produced will begin to be registered here.

At VNITS MV it will be possible to find out which are the most up-to-date source materials for the manufacture of parts, machines, mechanisms, instruments and structures, as well as which substances and what compositions of them are best to use in technological, power-engineering and other types of processes. This pertains primarily to fuels, oils, lubricants, chemical reagents, coolants, catalysts and so forth.

Information received at the center will be constantly updated. An automated system of storage, retrieval and reproduction of information will make it possible to meet the current needs of users.

The effectiveness and timeliness of information on the topics of scientific research being conducted by academy and industry institutes and by higher educational institutions will be heightened in a comprehensive fashion.

This year, with the supervision of the USSR State Committee for Science and Technology and of Gosstandart, producers of materials and their users will categorize the nomenclature of registered materials and their properties and characteristics, and will establish procedures for carrying out this work and for using the existing data in the country's economy. The registering of materials at VNITS MV will commence in 1985.

FTD/SNAP
CSO: 1842/014

CORROSION RESISTANCE OF CONCRETES TESTED WITH CLIMATE CHAMBER

Moscow STROITEL'NAYA GAZETA in Russian 23 Sep 84

[Article by Yu. Ursov]

[Excerpt] We were in the climatic testing room of the corrosion laboratory of the Scientific Research Institute of concrete and Steel-Reinforced Concrete. In the room there was a huge metal cylinder with a ring of windows around its middle. Laboratory assistants carefully carried into the cylinder a tank containing bars of a milky gray color, which were immersed in a salt solution.

"We are conducting corrosion-resistance tests of a new type of concrete for builders of Yakutia," explained Professor F. Ivanov, head of a sector. "The temperature inside the cylinder will now drop to minus 70 degrees, and the solution will simulate the environment in which buildings made of our concrete will have to stand."

"Our laboratory can issue recommendations and prepare concrete of the necessary brand for construction anywhere in the Soviet Union and exposure to any corrosive agents," said Professor S. Alekseyev, head of the laboratory. "In so doing, we can guarantee that the concrete or reinforced concrete proposed will not corrode in the course of a specified period."

FTD/SNAP
CSO: 1842/014

UDC: 539.612:539.216.2

INFLUENCE OF ION RADIATION ON ADHESION OF METAL CONDENSATES TO GLASS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar-Apr 84
(manuscript received 29 Dec 82) pp 70-75

KOVALENKO, V. V. and UPIT, G. P., Riga

[Abstract] This work presents a study of the influence of ionization of precipitated vapors and bombardment of substrates by argon ions on adhesion of metal condensates to the surface of glass. The results produced are compared to the results of a study of the adhesion of metal condensates to fresh glass surfaces obtained by fracturing specimens in vapors of the metal to reveal factors activating adhesion in ion bombardment. The substrates were borosilicate glasses type S49-2 and S52-1 prepared by fracturing in air or in vapors of the metal being deposited after diamond notching of glass rods 6 mm in diameter. Indium was the metal primarily deposited due to its low ionization potential and comparatively high degree of ionization of vapors. Indium does not enter into substitution reactions with the components of the glass used in the work, allowing the adhesion of the metal-glass system itself to be studied. Ionization of the vapor was performed by electron bombardment in a coaxial ionizer. The adhesion of the condensates to the glass following contact with the atmosphere increased to the level of freshly fractured surfaces for indium, even higher following argon ion bombardment. The increase in adhesion is explained by modification of the surface of the substrates under the influence of ion bombardment. Factors which influence the adhesion of metal condensates to the glass include accumulation of charge on the surface of the substrate and destruction of the surface layer to form an intermediate condensate-substrate transition layer. The activating effect of these factors depends on the nature of the metal being deposited. For simultaneous deposition and ion bombardment the greatest increase in adhesion is achieved for metals with $\Delta G < 0$. Figures 3; references 15: 6 Russian, 9 Western.
[116-6508]

STRUCTURE AND PHASE TRANSFORMATIONS IN PbTe-In₂Te₃ FILM COMPOSITE OBTAINED BY LASER EVAPORATION

Moscow POVERKHNOST' in Russian No 7, Jul 84
(manuscript received 22 Jan 83) pp 119-124

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[Abstract] Electronographic and electron-microscope studies were performed of PbTe-In₂Te₃ film composites. Phase transformations during annealing of films were studied upon heating of the specimens in a microscope column by an electron beam. The films produced had a well-oriented crystalline component, PbTe. Orientation of the PbTe was the usual for epitaxial growth on alkaline halide crystals. The specimen is a granulated film with isolated PbTe crystals, meaning that cyclic concentration of PbTe and In₂Te₃ forms not monolayer films but heterogeneous composites with one of the components growing in the form of oriented crystalline islands, the other retained in the amorphous state. Moderate heating by electron beam caused gradual crystallization of the amorphous phase. During annealing the crystalline In₂Te₃ phase grew from the amorphous component, with orientation the same as with PbTe crystals. Electronographic studies showed that specimens consisting initially of amorphous and crystalline phases after long-term holding for a month or more at room temperature in air become fully amorphous in some places. PbTe is thus dissolved in In₂Te₃, forming an amorphous solution. Figures 3; references 7: 6 Russian, 1 Western.
[156-6508]

LASER PROCESSING OF SILICON PLATE SURFACES

Moscow POVERKHNOST' in Russian No 7, Jul 84
(manuscript received 15 Nov 82; in final form 30 May 83) pp 113-118

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[Abstract] An experimental study was made of the structure of the surface layer of silicon plates after laser treatment. The effect of this treatment on defect content, epitaxial layers and charge properties of Si-SiO₂ division boundaries was studied. The studies made it possible to evaluate the effectiveness of using laser working of a planar surface of the initial plates in the technology of manufacture of bipolar and MOS integrated microcircuits. Photomicrographs and x-ray diffraction pictures are presented.

It was found that laser treatment improves the structure of the surface layer of the silicon, decreasing mechanical stresses. The charge in the oxide and the density of fast surface states at the silicon-dielectric boundary decreases by approximately a factor of 2 upon laser treatment of the surface before thermal oxidation. Dislocation density in epitaxial films grown on laser treated silicon surfaces is one-fourth as great as an epitaxial films manufactured by the normal method. Laser treatment can be performed in air. Figures 6; references 3: 2 Russian, 1 Western.
[156-6508]

UDC: 534.13.539.374

OSCILLATIONS OF AN ELASTIC BILAYER PLATE

Kiev PROBLEMY PROCHNOSTI in Russian No 6, Jun 84
(manuscript received 12 Jun 83) pp 28-31

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[Abstract] An analytic solution is obtained for the problem of oscillation of a circular elastic bilayer plate under very general assumptions. Kirchhoff's hypothesis is accepted for the load-bearing rigid layer, Reissner's hypothesis of the rectilinear normal is accepted for the soft layer. A cylindrical coordinate system is coupled to the mid-surface of the load-bearing layer. Bending in all layers is assumed identical. Equations are derived which describe the free and forced oscillations of the plate. The form of the solutions and the eigenfunctions is independent of the boundary conditions, which change only the natural oscillating frequencies. Figures 2; references 8: all Russian.
[149-6508]

UDC: 539.376

FRACTURE UNDER CREEP CONDITIONS

Kiev PROBLEMY PROCHNOSTI in Russian No 6, Jun 84
(manuscript received 4 Jul 83) pp 7-9

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[Abstract] A criterion of long-term strength is formulated considering great deformations and fracture of material. An earlier work by the same author considered the case of brittle materials which fracture with small deformation under creep conditions. The general criterion of long-term strength is represented on a figure as a curve which under great stresses asymptotically approaches the criterion of Hoff, while the brittle fracture condition derived in this article serves as the asymptote under smaller

stresses. This allows the prediction of serviceability of structural materials over a broad range of stresses with minimal experimental data. Figures 1; references 12: 5 Russian, 7 Western.
[149-6508]

UDC: 620.171.32

INFLUENCE OF MICROSTRUCTURE AND CONTENT OF MANGANESE ON MECHANICAL PROPERTIES OF CAST IRON WITH SPHEROIDAL GRAPHITE

Kiev PROBLEMY PROCHNOSTI in Russian No 7, Jul 84
(manuscript received 27 Dec 83) pp 68-71

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[Abstract] A study was made of the mechanical characteristics of three typical high strength cast irons with spheroidal graphite, differing in the shape and dimensions of graphite inclusions and the structural matrix. The types of cast iron differed basically in manganese content, which has a significant improving and hardening influence. One of the three types was heat treated at 900°C for 3 hours and then cooled in air. The form of the graphite inclusions was evaluated by the quantitative degree of spheroidization of graphite. The influence of microstructure and content of manganese on properties of these cast irons was studied. An increase in the content of manganese and pearlite in the cast iron was found to decrease ductility. At low manganese content in ferritic cast iron the relative elongation may reach 20-25%. Increasing manganese content to 0.6% causes ductility to be halved. The content of pearlite has a still greater influence on ductility. At high pearlite contents, relative elongation is not over 2-4%. Impact toughness also decreases with increasing Mn and pearlite content. An increase in graphite inclusion diameter decreases impact toughness for viscous fracture, increasing it for brittle fracture. The number of graphite inclusions does not significantly influence strength, though volumetric content of these inclusions does. Figures 5; references 9: 3 Russian, 6 Western.
[146-6508]

DAMAGE TO REINFORCED PLATES AT HIGH TEMPERATURES

Kiev PROBLEMY PROCHNOSTI in Russian No 7, Jul 84
(manuscript received 9 Mar 83) pp 36-40

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[Abstract] A study is made of physical processes occurring in a microscopic volume of material, a cube with an edge length of about 0.5 mm, in a reinforced plate which is loaded briefly (for a few minutes) so that it acts as a brittle material. It is assumed that damages are distributed through the volume uniformly, and that the difference between inelastic and elastic deformation is that in the former case there is additional irreversible increase in the deformation of the material due to accumulation of damage with bonds between molecules broken, whereas in elastic deformation the additional increase in deformation causes only elastic displacement of molecules. Cases of accumulation of damage under the combined influence of heating and mechanical loading are primarily studied. The experiments confirmed that in a homogeneous stress state the damages and their accumulation depend basically on the stress tensor components. In a homogeneous anisotropic medium, the damage tensor must be selected as a second order tensor. The change in internal energy in this case as applicable to the reinforced plates studied is described by an equation which includes a potential representing the increase in internal energy and an elementary damage event. This quantity is generally a second order tensor. Figures 3; references 3: all Russian.
[146-6508]

INTERACTION OF MULLITE WITH CARBON

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 4, Jul-Aug 84
(manuscript received 31 Mar 83) pp 28-32

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[Abstract] A study is presented of the kinetics of reduction reactions occurring on the surface of solid mullite and the composition of the gas phase formed. The thermodynamic estimate of the gas phase composition was compared with the equilibrium CO_2 pressure. Experiments were performed in graphite crucibles in a sealed furnace with a graphite heater. The results indicate that the reduction reaction at the mullite-reducing gas division boundary is controlled by diffusion of the reducing gas CO and the product SiO_2 and CO_2 through the layer of porous Al_2O_3 in the 1773-2023°K temperature range studied. Where the CO pressure is 0.1 MPa, the carbon monoxide acts

as a reducing agent in the presence of solid carbon. The contribution of the reaction of dissociation of mullite to the process of reduction increases with a decrease in total pressure. In addition to the thermal decomposition of the mullite to SiO_2 and $\text{Al}_2\text{O}_3(\text{s})$, aluminum oxide is converted to the gas phase. There is a correlation between the rate constant of the reaction and the partial pressure of silicon in the system. Figures 4; references 10: 7 Russian, 3 Western.
[145-6508]

UDC: 669-419

SOME REGULARITIES OF FORMATION OF A BIMETALLIC JOINT WITH COMBINED PLASTIC DEFORMATION OF SIMILAR AND DISSIMILAR METALS

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 4, Jul-Aug 84
(manuscript received 14 Jul 82) pp 96-99

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[Abstract] The phenomenon of development of a stepped relief on the contacting surfaces of interacting metals is universal and must be considered one stage in the formation of a bimetallic joint, related to the physical nature of deformation and processes of diffusion in the crystalline lattices of the metals. The development and evolution of deformation relief was studied upon rolling of two-layer packets 4.0 mm thick on a duo mill with roll diameter 235 mm and rolling speed 0.025 m/s in the 5-35% deformation interval. Comparison of processes of development of roughness indicates that hardening intensifies the process of extrusion of strips with slipping. Metals with cubic lattices are hardened more intensively by interaction of large numbers of dislocations with each other, forming obstacles to their movement over the slipping planes. Deformation relief is related to both intergrain and intragrain slipping mechanisms. The phenomenon of nonuniformity of deformation among layers during formation of a bimetallic joint has a positive effect in the stage of formation of the physical contact, activating the process of development of deformation relief on the surface between the layers. Figures 2; references 9: all Russian.
[145-6508]

STUDY OF MECHANISM OF MODIFICATION OF PRIMARY STRUCTURE OF CAST ALLOYS BY
DISPERSED NONMETALLIC PARTICLES

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 4, Jul-Aug 84
(manuscript received 1 Mar 83) pp 109-116

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[Abstract] Results are presented from a continued study of the interrelationship between grain size, number and dimensions of dispersed nonmetallic particles in cast alloys. The purpose of the studies was to refine the physical mechanism of structural change and determine the possibility of its application for the solution of practical problems. The objects of the study were an Fe+4% Mo alloy (alloy 1) and commercial castings from 20GSL and 15Kh1M1FL steels (alloys 2 and 3). The influence of the addition of cerium on the shape, dimensions and number of nonmetallic inclusions and grain size was studied by vacuum melting. It was found that the primary crystallite breaks down into smaller secondary grains in cast alloys with dispersed nonmetallic particles. There is a quantitative relationship between mean secondary grain size, mean dimension of dispersed nonmetallic inclusions and their volumetric content. The addition of cerium and rare earth metals modifies the primary structure by sharply decreasing nonmetallic inclusion diameter without changing volumetric content, thus reducing the size of secondary grains, particularly the austenitic grains in the steels (alloys 2 and 3). Figures 6; references 14: 13 Russian, 1 Western.
[145-6508]

UDC: 669.788:539.4

ROLE OF HYDROGEN IN PROCESSES OF DEFORMATION AND FRACTURE OF METALS

Kiev FIZIKO-KHIMICHESKAYA MEKhanika MATERIALOV in Russian Vol 20, No 3,
May-Jun 84 (manuscript received 16 Aug 83) pp 23-26

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[Abstract] A study is presented of the influence of hydrogen on plastic deformation and fracture of metal. The decrease in ductility of hydrogenized iron is explained primarily by the interaction of the hydrogen with dislocations and their blocking, similar to processes of aging of deformed iron containing carbon and nitrogen. The displacement of the threshold of cold shortness in the area of elevated temperatures and the absence of hydrogen embrittlement at high temperatures can be explained by the process of increasing the degree of localization of valent electrons in the metal by hydrogen, which leads to a decrease in the width of dislocations and an increase in Payerls-Nabarro forces. Hydrogen accumulates in metals at moderate temperatures

primarily at phase division boundaries, in cavities and cracks, at nascent cracks and clusters of vacancies formed by combination of dislocations or vacancies during deformation. Hydrogen, accumulated in the area of a developing defect, determines the degree of filling of newly formed surfaces with hydrogen atoms, which in turn weakens the bond force between atomic surfaces. The minimum metal surface atom bond force is observed upon adsorption of hydrogen onto surfaces with degrees of filling of over 0.35, 1.2 and 0.6 for nickel, tungsten and iron, respectively. This explains the low ductility of hydrogenated metal at low deformation speeds, the increase in Young's modulus, decrease in Poisson's ratio and facilitation of fracture, as well as the prevention of seizure of tools with metal being worked when hydrogen is present. Figures 1; references 15: 13 Russian, 2 Western.
[141-6508]

UDC: 621.791.92+669.14-419.8+539.219.3+539.4

INFLUENCE OF MELTING CONDITIONS ON STRENGTH OF TRANSITION ZONE BETWEEN
STEEL AND COMPOSITE MATERIAL

Kiev FIZIKO-KHIMICHESKAYA MEKhanika MATERIALOV in Russian Vol 20, No 3,
May-Jun 84 (manuscript received 22 Dec 80) pp 82-87

BELOUSOV, V. Ya., Ivano-Frankovskiy Institute of Oil and Gas

[Abstract] A study is made of the influence of surfacing conditions (temperature and time of the process) of homogeneous tungsten carbide composites on steel 20 with plastic alloys as the binder. The composites were manufactured by saturation. A charge consisting of refractory macroheterogeneous tungsten carbide granules and plastic alloy powder was pressed into briquettes and sintered in a neutral medium at 1473°K for various amounts of time. It was found that as the depth of the diffusion layer increased, its ultimate strength also increased. The less the mechanical heterogeneity of the joint produced between coatings and base, the more favorable the influence of increasing the relative thickness of the diffusion zone. The greater the mechanical heterogeneity of the joint, the thinner the diffusion interlayer must be between the two dissimilar materials. Figures 4; references 8: all Russian.
[141-6508]

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